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International Agreement Report

Assessment of RELAP5/MOD3.1 With the LSTF SB-SG-06 Experiment Simulating a Steam Generator Tube Rupture Transient

Prepared by
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Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
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under the International Thermal-Hydraulic Code Assessment
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The objective of the present work is to identify the predictability of RELAP5/MOD3.1 regarding thermal-hydraulic behavior during a steam generator tube rupture (SGTR). To evaluate the computed results, LSTF SB-SG-06 test data simulating the SGTR that occurred at the Mihama Unit 2 in 1991 are used. Also, some sensitivity studies of the code change in RELAP5, the break simulation model, and the break valve discharge coefficient are performed. The calculation results indicate that the RELAP5/MOD3.1 code predicted well the sequence of events and the major phenomena during the transient, such as the asymmetric loop behavior, reactor coolant system (RCS) cooldown and heat transfer by natural circulation, the primary and secondary system depressurization by the pressurizer auxiliary spray and the steam dump using the intact loop steam generator (SG) relief valve, and so on. However, there are some differences from the experimental data in the number of the relief valve cycling in the affected SG, and the flow regime of the hot leg with the pressurizer, and the break flow rates. Finally, the calculation also indicates that the coolant in the core could remain in a subcooled state as a result of the heat transfer caused by the natural circulation flow even if the reactor coolant pumps (RCPs) turned off and that the affected SG could be properly isolated to minimize the radiological release after the SGTR.

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Executive Summary

The RELAP5 code has been developed as one of the best-estimate codes. The code is based on a non-homogeneous and non-equilibrium model for one dimensional, two-phase flow. Recently, the RELAP5/MOD3 code development program has been initiated to develop a code version suitable for the analysis of all transient and postulated accidents in PWR systems

The objective of present work is to evaluate the predictability of the RELAP5/MOD3.1 on major thermal-hydraulic behavior during the Steam Generator Tube Rupture (SGTR) accident. Such a transient behavior includes following phenomena; the asymmetric loop behavior, the RCS cooldown and heat transfer by the natural circulation, system depressurization, and so on. To do this, the calculation results are assessed and compared with the LSTF SB-SG-06 test data simulating the single SGTR accident occurred at Mihama Unit 2 in 1991. Also, some sensitivity studies are performed on items which may have influence on the prediction of the transient behavior; RELAP5 code version, break simulation model and break valve discharge coefficients. Finally, from these analysis results, the capability of core recovery and contaminated coolant isolation following the SGTR accident are discussed briefly.

The LSTF is large scale facility which is a 1/48 volumetrical scale of PWR and also the LSTF test data agreed well with the transient behavior observed in Mihama Unit 2 power plant. Thus, it is expected that the RELAP5/MOD3.1 can give reliable calculation results to applicable to real plant if the present calculation predicts well the LSTF test data. Comparing the present calculation results with the the SB-SG-06 test data, overall transient behavior predicted by using RELAP5/MOD3.1 was in a good agreement with the experiment and the following conclusions were obtained.

- 1) The RELAP5/MOD3.1 predicted well the sequence of events and the major phenomena during the transient, such as the asymmetric loop behavior, the RCS cooldown and heat transfer by the natural circulation, primary and secondary system depressurization by the pressurizer auxiliary spray and the steam dump using the intact loop SG relief valve, and so on. However, there were differences in some items, such

as the number of the relief valve cycling in the affected SG, the flow regime of the hot leg with the pressurizer and the break flow rates.

2) The RELAP5/MOD3.1 overestimated the number of the RV cycling in the isolated SG. In the experiment, the pressurization rate in the affected SG steam dome was determined as a result of the condensation and compression of the steam by the ascending SG water level rather than the vaporization. However, the code may not properly predict this type of the wall and steam-water interface condensation phenomena. The frequent RV opening had influence on the break flow rate and caused the overestimated break flow rate. Hence, to obtain the accurate transient behavior including the break flow rate, it may be necessary to improve the model on the wall and steam-water interface condensation under superheated situation in the RELAP5/MOD3.1.

3) The results of sensitivity studies shows that, in the early phase of the transient, the results using the RELAP5/MOD3.1 agreed better with the experiment than that of the MOD3.0 code. Also the break flow rate was sensitive to the break simulation model and the break valve discharge coefficient. Especially, the break nozzle model based on the LSTF test configuration provided better agreement with the experiment than the break valve model. Also, in case simulating the SG U-tube rupture as the break valves, the discharge coefficient, C_d of the break valves had strong influence on the break flow rate.

I. Introduction

A Steam Generator Tube Rupture (SGTR) Accident is initiated from the break of the barrier between the Reactor Coolant System (RCS) and the secondary Main Steam System (MSS), which results from the failure of Steam Generator (SG) U-tube. In general, the degradation of the SG U-tube integrity is caused due to the vibration, corrosion and crack for the long plant operation. Because the occurrence probability of the SG U-tube rupture is relatively higher than the RCS piping, the issue on the degradation of SG U-tube integrity has been studied as one of the Unresolved Safety Issues (USIs) by the USNRC for a long time [1].

In the view point of radiological release, the integrity of the barrier between the RCS and the secondary MSS is very significant. Such a SGTR accident could provide the direct release path of contaminated coolant to the environment. Also SGTR accident induces a rather complex phenomena on the plant responses, such as the asymmetric loop behavior, RCS cooldown using natural circulation in intact loop, depressurization of each system and energy transfer between primary and secondary systems. As a consequence, it is necessary that an operator understand precisely the plant behavior during the accident and some actions to minimize the radiological consequences be prepared. Almost all the reports analyzing the SGTR accident clearly show that there are the substantial operator involvements required to mitigate the consequence of the events. Such operator actions may include the isolation of the affected SG to contain the contaminated coolant, the pressurizer power operated relief valve (PORV) open or auxiliary spray actuation to depressurize the primary pressure, the atmospheric steam dump in intact SG, high pressure safety injection (HPSI) pumps termination, reactor coolant pumps (RCPs) restart, and so on.

On February 9, 1991, a single tube in steam generator was ruptured in Mihama Unit 2 in Japan. The Mihama Unit 2 has been operated since 1972, and its nuclear steam supply system design was supplied by Westinghouse with Model 44 steam generator. The cause of the tube rupture was reported as the incorrect insertion of anti-vibration

bars, which could not protect the tube from the fatigue by fluid elastic vibration. The Japan Atomic Energy Research Institute (JAERI) carried out the integral simulation experiments on the SGTR incident that occurred at the Mihama Unit 2 power station. The experiment was conducted at the Large Scale Test Facility (LSTF) of the ROSA-IV Program [2,5]. The objective of the experiment was to provide the detailed thermal-hydraulic experimental data, that supplement the plant records, to be used for in-depth evaluation of the SGTR incident and for validation of computer-code. The experimental results indicated that the sequence of events and the behavior of system parameters agree well with Mihama Unit 2 records, and confirmed that there is a large margin in the core cooling capability during the SGTR incident.

The objective of present work is to evaluate the predictability of the RELAP5/MOD3.1[4] on major thermal-hydraulic behavior during the SGTR accident. Such a transient behavior includes following phenomena; the asymmetric loop behavior, the RCS cooldown and heat transfer by the natural circulation, primary and secondary system depressurization by the pressurizer auxiliary spray and the steam dump using the relief valve, and so on. To do this, the calculation results are assessed and compared with the LSTF SB-SG-06 test data simulating the single SGTR accident occurred at Mihama Unit 2. As mentioned above, the LSTF test data agreed well with the transient behavior observed in Mihama Unit 2 nuclear power plant. Also, the LSTF is large scale facility which is a 1/48 volumetrical scale of PWR. Thus, it is expected that the RELAP5/MOD3.1 can give reliable calculation results to applicable to real plant if the present calculation predicts well the LSTF test data. Also, in present work, some sensitivity studies will be performed on items which may have influence on the prediction of the transient behavior, such as RELAP5 code version and break simulation model. Finally, from these analysis results, the capability of core recovery and contaminated coolant isolation following the SGTR accident will be briefly discussed.

The Chapter II includes a description of the LSTF and experimental conditions and procedures. A code description and modelling of the facility including nodalization

and control logics are described in Chapter III. The calculation results are discussed in detail with a experimental data in Chapter IV. In particular, the discussion involves an assessment of the major phenomena during SGTR accident. The code predictability and run statistics are also described in this chapter. The conclusions obtained through the present study are summarized in Chapter V. Finally, the RELAP5/MOD3.1 input deck for steady state run and transient run are attached as an Appendix A and B, respectively.

II. Experimental Facility, Conditions and Procedures

II.1 Facility Description

The LSTF is a 1/48 volumetrically scaled model of a Westinghouse type 3423 MWt four loop PWR[2]. The LSTF has the same elevations as the reference PWR to simulate the natural circulation phenomena and large loop pipes to simulate the two-phase regimes and major phenomena in an actual plant. Figure 1 shows the flow diagram of the LSTF. The facility was designed to be operated at the same pressures and temperatures as the reference PWR.

The LSTF facility simulates the major components of the PWR primary system (for example, pressure vessel, pressurizer, SGs, RCPs, etc.) and the reactor protection system (for example, emergency core cooling system, auxiliary feedwater system, etc.) that have an impact on the plant behavior during the operational transients. Equipment controls allow the test operators to either follow procedures defined in standard plant manual or follow variations of standard procedures. Other systems, such as the secondary and various auxiliary systems, are capable of achieving pretest steady-state conditions and simulating the primary to secondary interactions. These systems include feedwater, condensate and steam systems together with component service systems such as the cooling water, water purification etc.

The fuel assembly dimensions, i.e. the fuel rod and the guide thimble diameter, pitch and length, and the ratio of the number of fuel rods to the number of guide thimbles were designed to be the same as the 17 x 17 fuel assembly of the reference PWR to preserve the heat transfer characteristics of the core. The total number of rod which was scaled by 1/48, is 1064 for the electrically heated and 104 for the unheated rods. The most important design scaling compromise is the 10 MW maximum core power limitation, 14% of the scaled reference PWR rated power. The steady-state condition is therefore restricted to a core mass flow rate that is 14% of the scaled value, to simulate the reference PWR temperature distribution in the primary loop.

The four primary loops of the reference PWR were represented by two equal-volume loops. The hot and cold legs were sized to conserve the volume scaling and the ratio

of the length to square root of the pipe diameter, $L/D^{0.5}$ for the reference PWR, in expectation that the flow regime transitions in the primary loops can be simulated appropriately by taking this scaling approach.

II.2 Experimental Conditions and Procedures

The experiment (SB-SG-06 test simulated an accident with SG single tube rupture) was initiated by opening a break valve nearly at the same RCS pressure and temperature as in Mihama Unit 2. The reactor trip signal and safety injection signal were sent automatically at the same RCS setpoint pressures as in Mihama Unit 2. Then, the HPSI systems were actuated and the HPSI flow was directed to the cold legs and vessel upper plenum. The damaged SG was isolated at 12 minutes after reactor trip. At the same time, depressurization of intact SG secondary side was initiated. Such a depressurization was terminated according to the Mihama Unit 2 Emergency Operating Procedure (EOP). Subsequently, the atmospheric relief valve (RV) on the damaged SG opened and closed automatically.

In order to stop the break flow by reducing the primary pressure, the pressurizer PORVs were tried to open in the real plant, but it failed to open. Thus the pressurizer auxiliary spray was used instead of the PORV. The pressurizer auxiliary spray was actuated 44 minutes after reactor trip to depressurize the RCS. The HPSI pumps were turned off after the pressurizer water level recovered. The pressurizer auxiliary spray was turned off after the RCS pressure equilibrated with the damaged SG pressure. Finally, the RCP in intact loop was restarted at 65 minutes after reactor trip. The experiment was ended when the RCS conditions were stabilized. The overall event sequences of the SGTR transient can be shown in Table 3.

The measurement systems were developed and installed to measure the various thermal hydraulic phenomena associated with the experiment. Installed locations and measuring range for all instruments and data acquisition system in LSTF were in detail described in reference 2. In particular, the estimated accuracy of the experimental data used in this study was presented with the origin of the measured data in Table 4.

III. Code and Modeling

III.1 Code Description

The RELAP5 code has been developed as one of the best-estimate codes. The code is based on a non-homogeneous and non-equilibrium model for one dimensional, two-phase system that is solved by a fast, partially implicit numerical scheme to permit economical evaluation of system transients. Recently, the RELAP5/MOD3 code development program has been initiated to develop a code version suitable for the analysis of all transient and postulated accidents in PWR systems including both large and small break LOCAs as well as the full range of operational transient. Although the emphasis of the RELAP5/MOD3 development is on large break LOCA, improvements to existing code models, based on the results of assessments against operational transient test data, are also being made. In this code assessment on the SGTR transient, the unmodified released code version, RELAP5/MOD3.1 and MOD 3.0 are used.

III.2 Modeling Description

The nodalization used to simulate the LSTF facility of the ROSA-IV program with the RELAP5 code is represented in Figure 2. The model is based on 177 volumes connected by 186 junction and 166 heat structures composed of 947 mesh points for averaged U-tube model case. In the reactor vessel elements (volumes 100 to 156) the volumes corresponding to the downcomer, the lower plenum and upper plenum, the core, the upper head and the guide thimble channel are defined. In the schematization of the upper part of the LSTF downcomer (volumes 100 and 104), care was taken to correctly simulate the steady-state mass flow rates in the connection with the hot legs (bypasses), the upper plenum (unintentional leak path) and the upper head (spray nozzles) to obtain the requested values, i.e. 0.1 %, 0.085 % and 0.3 % of the core inlet flow rate, respectively. The core is modeled by one channel arranged in 6 hydraulic volumes, in which only one series of heat structures is adopted to simulate the fuel

assembly (i.e. a flat radial core power profile is assumed). The reason for this choice resides in the attempt to perform the simplest modeling of the LSTF facility as possible. A pipe connection (volume 156) between the upper head and the upper plenum of the pressure vessel is introduced in the scheme to simulate the guide thimble channel path existing in the facility.

The two loops of the LSTF system are represented by the intact-loop (volumes 200 to 299) and the broken-loop (volumes 400 to 499) in an almost symmetrical way. In fact, each of the two loops presents the hot leg, the SG inlet and outlet plena, the SG U-tube channel, the loop seal, the reactor coolant pump, the cold leg. In addition, the pressurizer is connected to the intact-loop hot leg by means of the surge line element. In the volumes representing the pressurizer vessel, an additional heat structure is introduced to simulate the effects of the proportional and back-up heaters. But the pressurizer heaters are not used in this case of SGTR transient. The two SG secondary sides (volumes 300 to 399 and 500 to 599) are simulated using an identical schematization. They can be subdivided into the downcomer, the boiling section, the steam separator and the steam dome. The steam and feedwater lines are simulated by using Time Dependent Junctions with imposed flow rates. The relief and safety valves are also connected to the SG steam dome using valve components in which the operational setpoints and conditions are specified to be the same as the experiment.

The U-tube break models are examined for two cases as shown in Figure 3. Case 1 is to simulate the double-ended break as a single-ended break nozzle based on the LSTF SB-SG-06 test configuration. Figure 4 shows the break line arrangement in LSTF. The break nozzle is a straight, cylindrical pipe of 6.2 mm in inner diameter and 1.8 m in length. Such a nozzle is to simulate the scaled break area and length as well as the pressure drop along the ruptured tube. In this report, this break nozzle modelling case, i.e., Case 1 will be regarded as a base case calculation. Case 2 is to simulate the U-tube rupture as two break valves between a single broken U-tube channel and secondary SG. The valve junction diameter is 6.2 mm and the single broken U-tube size is 19.6 mm in inner diameter as in LSTF experiment. The remaining SG U-tubes are modeled as an averaged single U-tube.

IV. Analysis Results and Discussion

IV.1 Analysis Conditions

As a base calculation, the released code version without modification, RELAP5/MOD3.1 is used to identify the code predictability on the thermal-hydraulic behavior during the SGTR accident. Table 1 represents the comparison of initial conditions between the LSTF SB-SG-06 test and the calculation. The calculated values were obtained from the steady state run. It is indicated that the major calculated parameters of the primary and secondary coolant systems agree well with the measured values in LSTF SB-SG-06 test.

Table 2 represents the setpoints and conditions used in calculation. These conditions are based on the specified operational setpoints and conditions of the experiment. However, the experimental information was not enough to accurately simulate the transient behavior. Thus, some control logics such as timing of termination of HPSI into upper plenum were modelled in accordance with the experimental results. The calculation was attempted up to 5000 seconds when the operator's recovery procedure is initiated as in experiment.

Table 3 represents the major sequence of the events during the SGTR transient. The major events are composed of the reactor trip, auxiliary feedwater actuation, high pressure safety injection (HPSI), affected SG isolation (MSIV close) and intact SG depressurization (RV open), RV cycling in affected SG, pressurizer auxiliary spray actuation, and so on. Two calculations depending on the break simulation model were performed and the table is showing the similar sequence of the events. As a base calculation, the computed results of the Case 1, which based on the LSTF SB-SG-06 test configuration, are compared with experimental data and are in detail discussed in following section. The experimental data compared in this study were obtained by digitizing curves of the figures in open literatures [5,6]. The origin of the experimental data including the estimated accuracy and the corresponding calculated parameters are listed in Table 4.

Also, in these base and sensitivity calculations, the general and specific practices for

applying RELAP5 including standard procedures, option selection related to volume and junction, special model applications such as break model and crossflow model, control and trip logics and so on, are used. Hence there are no deviations from the user guidelines described in RELAP5/MOD3 code manual volume V.

IV.2 Analysis Results

1. RCS Pressure Response

Figure 5 shows the primary system pressure behavior during the SGTR transient. After the initiation of single SG U-tube rupture, the pressurizer pressure and water level decrease monotonically because the amount of break flow to SG secondary side is larger than the coolant supplied by the charging pumps. The reactor scram occurs when the RCS pressure reaches 13.42 MPa. After that, the pressure and water level continue to decrease. The pressurizer water level behavior will be discussed later (Figure 11). Following the continuous decrease of the RCS pressure, the pressure reaches to the setpoint of the safety injection signal and the RCP trip. The high pressure safety injection (HPSI) into cold legs and upper plenum of the reactor vessel begin to deliver at 98 seconds and 300 seconds after the safety injection signal, respectively. The RCPs coastdown at 80 seconds after the reactor scram. The pressurizer is emptied completely at about 335 seconds.

The HPSI water continues to inject into primary side in order to recover the core inventory, while break flow enters secondary side through the break nozzle. The pressurizer auxiliary spray system instead of the pressurizer relief valves, is used to increase a depressurization rate at 2660 seconds after the reactor scram and the pressurizer water level is recovered from 3000 seconds. The HPSI systems are terminated after the pressurizer water level is recovered. When the RCS pressure becomes identical to the broken loop SG pressure, the pressurizer auxiliary spray is turned off. Finally, the RCP in intact loop is restarted about 4000 seconds after reactor scram, and the experiment and calculation are terminated at 5000 seconds when the primary system conditions are stabilized. The overall transient response of the calculated primary pressure agrees well with the LSTF SB-SG-06 test data.

2. Secondary Pressure Response

Figure 6 represents the secondary pressure behavior during the SGTR transient. The broken loop SG is isolated by closing the main steam isolation valve (MSIV) at 722 seconds after reactor scram and simultaneously the intact loop SG is depressurized by the latched open of the SG relief valve (RV). Such actions are to contain the contaminated coolant in the affected SG and to maintain the heat removal from primary to secondary through the intact SG, respectively. The pressure of broken loop SG increases due to the primary coolant inflow with high enthalpy and is controlled by opening and closing the SG RV. The break flow rate entered into the secondary side can be shown in Figure 17. Consequently the general trend of the calculated secondary pressure is analogous to the experiment. However, there exists the difference in the number of the RV cycling of broken loop SG. The RV was opened once in experiment, while it was opened several times in calculation. The difference will be discussed in detail in section IV.3.

3. Thermal Response

Figure 7 represents fluid temperatures at inlet, mid section and outlet of reactor vessel core. The RCS saturation temperature is also plotted in the figure. Figure 8 shows fluid temperatures on the broken loop SG secondary side. From this figures, it is found that there exists the sufficient subcooled margin in the primary side and the superheated steam in the broken loop secondary side during the SGTR transient. The RCS fluid temperatures decrease rapidly after the reactor scram. However, the core outlet fluid temperature increases slightly after RCPs trip, which is due to reduction of the heat transfer between primary side and secondary side.

The RCS fluid temperatures continue to decrease gradually by the atmospheric steam dump and feedwater in the secondary side and the HPSI cold water in the primary side. This explains that the core heat is removed by the natural circulation in the intact loop. Thus, the subcooled margin of RCS coolant becomes larger sufficiently to prevent the core voiding. They decrease rapidly at about 4300 seconds because of the forced convection caused from restart of the intact loop RCP. Figures 9 and 10 are the hot

leg fluid temperatures in intact loop and broken loop, respectively. The similar trends to the RCS fluid temperature are found. The overall transient responses of the calculated fluid temperatures agree well with the experimental data. However, in the early phase of the transient, there exists the bump in the experiment, while it is not seen in the calculation. The bump occurs when the hot water and steam in the pressurizer is penetrated into the hot leg after emptying of pressurizer at about 400 seconds.

4. Water Level Behavior

Figure 11 shows that the pressurizer is emptied completely at about 335 seconds and the water level is recovered from about 3000 seconds. The calculation result agrees well with the experiment. Figure 12 shows the SG water levels behavior in broken and intact loop SGs. After MSIV closure of the broken loop SG, the water level increases gradually by the primary coolant inflow through the break nozzle. The calculated water level increases with the similar rate as that in experimental data, however, the value of water level is slightly higher than that of experimental data. Such a calculation result is because the SG inventory is controlled to remain a reference water level up to main feedwater trip. Supposed that a detailed experimental information on the main feedwater and main steam flow rate will be given, this difference is expected to be reduced. The water level in intact loop SG rapidly decreases due to the atmospheric steam dump. However, to keep the heat removal from the primary side by the natural circulation, the SG inventory continues to be made up by the auxiliary feedwater system. The feedwater supply can be shown in Figure 19.

5. Loop Mass Flow Behavior

Figures 13 and 14 show the loop mass flow rates in the intact and broken loop, respectively. Although the mass flow in broken loop reduces to approximately zero after the RCP trip, the natural circulation flow through the intact loop is maintained more than 5 kg/sec, which is large enough to keep the core coolant subcooled. It is shown that the heat removal from primary side to secondary side is remained by the natural circulation during SGTR transient. The intact loop mass flow increases rapidly

at about 4000 seconds after reactor scram by restarting the RCP to stabilize the RCS conditions. Consequently, the calculation predicts well the experimental behavior.

Figures 15 and 16 show the HPSI flow rates into cold legs and core upper plenum, respectively. In general, the HPSI flow rate is depending on the RCS pressure. Thus the curves representing HPSI flow rate as a function of RCS pressure were used in calculation. As shown in Figure 15, the measured HPSI flow rate into core upper plenum has somewhat uncertainty, especially in the starting point and termination point. However, the overall behavior of the HPSI flow rate agrees well with the experimental data.

6. Break Flow Behavior

Figure 17 shows the break flow rate through the break nozzle during the SGTR transient. The break flow rate is influenced by the pressure difference between primary and secondary systems. Initially the pressure difference is very large, thus the critical flow is formed immediately after break initiation, and the break flow rate gradually decreases as reduction of the pressure difference. After the HPSI system actuation, the break flow rate again increases slightly depending on the RCS pressure. When the RV in the broken loop SG is opened, the break inflow from the primary side is increased instantaneously by the SG pressure drop. This rapid increase of the break flow rate appears several times periodically (due to RV cycling) in the calculation. After the RCS depressurization using the pressurizer auxiliary spray at about 2900 seconds, the pressures of both systems are nearly identical and the break flow rate becomes much smaller. This figure shows the RV cycling has strong influence on the break mass flow. The integrated break flow was calculated 3177 kg during the transient, which is larger than the measured value of 2600 kg approximately. Table 5 shows the comparison of the integrated total mass flow during transient and Figure 18 shows the integrated break flow and HPSI flow. Consequently, it is found that the frequent RV opening results in the large amount of the break mass flow. The sensitivity study on the break simulation model will be discussed in following section.

7. Others

Figures 19 and 20 show the calculated main and auxiliary feedwater flow rate into the secondary side. The main feedwater stops at about 280 seconds in both loops, while to ensure the secondary side inventory, the auxiliary feedwater continues to be supplied to the intact loop secondary side. Figure 21 shows the calculated mass flow rate of the pressurizer auxiliary spray to depressurize the RCS. Figure 22 shows the atmospheric steam dump mass flow rate in the intact loop secondary side through the latched open RV to keep the heat removal between primary and secondary side.

Comparing the present calculation results with the experimental data, it was found that the RELAP5/MOD3.1 code predicts well the single SGTR transient behavior and the timing of sequence of events. Also, it was found that the coolant in the core could remain as subcooled state by the heat transfer, which resulted from the natural circulation flow even during RCPs turned off, and the affected SG could be properly isolated to minimize the radiological release following the SGTR accident.

IV.3 Code Predictability

As discussed in the above section, the comparison between the available LSTF SB-SG-06 test data and the calculation results, indicates that the RELAP5/MOD3.1 code yields in general agreeable results for SGTR transient. However, there exist differences in some parameters from the experiment as follows.

Figure 6 shows the behavior of the SG secondary pressure for both intact loop and broken loop sides. The general trend agrees well with the experiment. However, the number of the relief valve opening in the broken loop SG is overestimated; several times in calculation, while once in experiment (three times in Mihama Unit 2). This difference may come from the insufficient nodalization and/or the modelling on the heat transfer in the secondary side. However, the code model on wall and steam-water interface condensation can be considered as one of the reason for the difference if the current modelling is reasonable one. As shown in Figures 8 and 10, the steam in the broken loop SG steam dome is superheated after about 1000 seconds and the break

flow entered from the primary system is subcooled. Also, since the SG water temperature becomes higher than the break flow (or hot leg) temperature, the heat transfer across the U-tube wall is reversed from secondary side to primary side. Figure 23 shows the reversed heat flux across the U-tube walls in the affected SG. Hence, one can conclude that the pressurization of affected SG mainly occurs as a result of compression of the steam phase by the ascending SG water level rather than the vaporization in SG. In the experiment, the pressure increasing rate was reduced by condensation on the wall and steam-water interface, but in the calculation, it was not predicted appropriately. Figure 24 shows the calculated heat flux across the SG steam dome wall. The experimental data relevant to the parameter was not available. However, the heat flux from the steam dome to environment, after 1000 seconds, may be not enough to reduce the pressure increasing rate to the experimental value. Those overprediction of pressure increasing rate is considered as a reason for the frequent RV opening/closing. Such a frequent RV opening, which results in the larger pressure difference between primary and secondary systems, had influence on the break flow rate and caused the overestimated break flow rate. Thus, to obtain the accurate secondary pressure behavior including the break flow rate, it may be necessary to improve the model on the wall and steam-water interface condensation under superheated steam situation in the RELAP5/MOD3.1 code.

In the experiment, as shown in Figure 9, the fluid temperature "bumps" appeared at the top of the hot leg to which the pressurizer was connected. It is a temporal increase of the fluid temperature only at the top of the hot leg. Most hot leg water remains subcooled. This phenomena occurred, after emptying of the pressurizer, when the hot water and steam in the pressurizer are penetrated into the hot leg where the subcooled water is flowing toward the SG. In addition, the experiment indicated that the slight stratified two-phase flow with small void fraction was observed at the top of the hot leg. However, the calculated hot leg bulk fluid temperature was just slightly increased and the "bumps" was not observed as shown in Figure 9. Also, the flow regime in the intact loop hot leg was predicted as a bubbly flow, which has the very small void fraction less than 0.1. This discrepancy may be caused from the difference in measured

location and the code limitation to calculate the temperature stratification in one dimensional model. The experimental data were measured at the top of the hot leg, while in analysis, the bulk temperature of the hot leg was computed. In fact, the averaged bulk fluid temperature measured in experiment may be lower than that of Figure 9. Figures 25 and 26 show that the pressurizer steam is penetrated into the hot leg through surge line around 400 seconds and the void is formed in the hot leg in the calculation.

IV.4 Sensitivity Study

Sensitivity study was performed on some items which may influence on the prediction of transient behavior, such as the primary pressure, the break flow rate, etc. The chosen items are the RELAP5 code version (MOD3.0 vs MOD3.1), the break simulation model as described in section III.2 and the break valve discharge coefficient, C_d for the break valve model case (from 0.15 to 0.2).

Figure 27 shows the comparison of the primary pressures which were calculated using RELAP5/MOD3.0 and RELAP5/MOD3.1, respectively. Although the pressure behavior for both cases after the HPSI was almost identical, the MOD3.1 predicted better the pressure trend in the early phase of the transient than the MOD3.0. The MOD3.1 was known to improve some deficiencies and errors from the MOD3.0 for following items; condensation model, spherical accumulator model, boron transport model and error corrections such as undamped flow oscillations in stagnant crossflow junctions, etc.[7] Although, from this calculation, it couldn't clearly find out the improved point of the code, the present calculation results indicated that the MOD3.1 was improved, especially in capability to predict the thermal-hydraulic behavior around the reactor trip.

Figure 28 shows the comparison of break flow rates calculated using the two different break simulation models. In the early phase, the break flow rates for the both cases were nearly identical, but, after the HPSI, the break flow rate for the Case 2 was

larger than that for the Case 1. As mentioned previously, the rapid increase of the break flow for the Case 1 was caused by the RV cycling in broken loop SG. However, even though the RV cycling also occurred in the Case 2, the rapid increase of the break flow rate was not occurred. It indicated that the critical flow was formed at the break valves in Case 2, that is, the break flow behavior was determined from the primary pressure instead of the pressure difference between primary and secondary systems. Consequently, it is found that the Case 1 simulating the double ended SG tube rupture as the break nozzle, based on the LSTF SB-SG-06 test configuration, agreed better with the experimental data than the Case 2 with break valve model. Therefore, it is found that the break nozzle model is more realistic, though the number of the RV opening was overestimated.

Figure 29 shows the comparison of the break flow rates calculated with a variation of discharge coefficient, C_d from 0.15 to 0.2, for the Case 2 modelling. As described above section, the critical flow was formed at the break valves in this case. The break flow rate from RCS to secondary side increased with increasing discharge coefficient. Especially, in case of $C_d=0.15$, the break flow rate after the reactor trip was nearly identical to the experiment. However, the break flow rate before the reactor trip was lower than that of experiment, and consequently the reactor trip time was delayed 200 seconds approximately. Therefore this case was not in good agreement with the experiment in the early phase of the transient. Table 5 describes the total break flow, total HPSI flow and total discharged steam flow throughout the transient. It can be stated that the total break and total HPSI flows increase with increasing C_d . In addition, the break flow and HPSI flow for the Case 1 were overestimated. As discussed above, the overestimated total break flow was caused by the frequent opening of the RV in the isolated SG, which results in the larger pressure difference between primary side and secondary side. Although the experimental data has somewhat its uncertainty range, Table 5 shows that the total discharged steam flow through the RV was predicted quite high. Because of this increased break flow, the total HPSI flow integrated during transient was also overestimated.

IV.5 Run Statistics

The main computer used in the present calculation was a DEC workstation 5000/240 with UNIX operating system. Figure 30 presents a plot of the required CPU time for the two cases during the SGTR transient. It is shown that Case 1 was required about ten times larger CPU time than that of Case 2. It may be because the Case 1 has another minor flow path between primary and secondary systems, which consists of some volumes and junctions. Figure 31 shows Courant time step and advanced time step size with respect to a real transient time. The time step size was reduced down to about 0.01 second.

The Case 1 transient run using RELAP5/MOD3.1 was terminated at 5000 seconds, and the required CPU time was 114,737 seconds including 11.6 seconds for input processing. The accepted advancement was 291,357 time steps. Therefore, the grind time can be calculated as follows,

CPU time	$\text{CPU} = 114,737 - 11.6 = 114,725.4 \text{ sec}$
Number of time step	$\text{DT} = 291,357$
Number of Volume	$\text{C} = 177$
Transient Real Time	$\text{RT} = 5000 \text{ sec}$
Grind Time	$\text{GT} = \text{CPU} \times 1000 / (\text{C} \times \text{DT}) = 2.2246 \text{ CPU msec/vol/step}$

V. Conclusions

The RELAP5/MOD3.1 was assessed using the LSTF SB-SG-06 test simulating the SGTR incident which occurred at the Mihama Unit 2 in 1991. To evaluate the code predictability on major thermal-hydraulic behavior, the calculation results are assessed and compared with the experimental data. LSTF is large scale facility of PWR, thus, it is expected that the RELAP5/MOD3.1 can give reliable calculation results to applicable to real plant if the present calculation predicts well the LSTF test data. Overall RELAP5/MOD3.1 calculation provided a good agreement with the SB-SG-06 test data for the SGTR transient and the following conclusions were obtained.

- 1) The RELAP5/MOD3.1 predicted well the transient behavior during the SGTR accident, such as the primary and secondary pressures, the temperatures of the core and hot legs, the break flow rate, HPSI flow rates, the pressurizer and SG water level, and so on. The calculation results also predicted well the sequence of events and the major phenomena during the transient, such as the asymmetric loop behavior, the RCS cooldown and heat transfer by the natural circulation, primary and secondary system depressurization by the pressurizer auxiliary spray and the steam dump using the intact loop SG relief valve, and so on. However, there were differences in some items when compared to the applicable test data. Those items are the number of the relief valve cycling in the affected SG, the flow regime of the hot leg with the pressurizer and the break flow rates.
- 2) The RELAP5/MOD3.1 overestimated the number of the RV cycling in the isolated SG. In the experiment, the pressurization rate in the affected SG steam dome was determined as a result of the condensation and compression of the steam by the ascending SG water level rather than the vaporization. However, the code may not properly predict this type of the wall and steam-water interface condensation phenomena. The frequent RV opening had influence on the break flow rate and caused the overestimated break flow rate. Hence, to obtain the accurate transient behavior including the break flow rate, it may be necessary to improve the model on the wall

and steam-water interface condensation under superheated situation in the RELAP5/MOD3.1.

3) The sensitivity study was performed on the RELAP5 code version, the break simulation model and the break valve discharge coefficient. In the early phase of the transient, the results using the RELAP5/MOD3.1 agreed better with the experiment than that of the MOD3.0 code. Also the break flow rate was sensitive to the break simulation model and the break valve discharge coefficient. Especially, the break nozzle model based on the LSTF test configuration provided better agreement with the experiment than the break valve model. Also, in case simulating the SG U-tube rupture as the break valves, the discharge coefficient, C_d of the break valves had strong influence on the break flow rate.

4) Finally, the analysis results indicated that the core coolant remained subcooled state by the heat transfer resulted from the natural circulation flow even during RCPs turned off, and the affected SG could be properly isolated to minimize the radiological release following the SGTR accident.

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- [7] Gray E. Wilson, "Proposed CAMP Protocols", Presented at the second CAMP Meeting, Tractebel, Belgium, May 1993.

Table 1 Comparison of Initial Conditions

Parameters	LSTF SB-SG-06 Measured		RELAP5/MOD3.1 Case 1		RELAP5/MOD3.1 Case 2	
Primary Coolant System	(Intact : Broken)		(Intact : Broken)		(Intact : Broken)	
Hot leg temperature (K)	587.4	585.9	586.02	586.02	586.0	586.0
Cold leg temperature (K)	560.5	560.0	560.85	560.76	560.74	560.72
Loop mass flow rate (kg/s)	34.65	33.84	36.580	35.478	36.579	35.480
Core mass flow rate (kg/s)	-		71.707		71.708	
Pump speed (rad/s)	128.3	124.3	128.3	124.3	128.3	124.3
Core power (MW)	10		10		10	
Pressurizer						
Pzr. pressure (MPa)	15.38		15.380		15.380	
Pzr. water level (m)	2.64		2.680		2.679	
Pzr. temperature (K)	-		616.28		616.28	
Secondary Coolant System						
SG steamdome pres.(MPa)	6.89	6.89	6.858	6.860	6.857	6.860
SG steam dome temp.(K)	-		557.56	557.58	557.55	557.57
SG steam flow rate (kg/s)	2.68	2.58	2.799	2.722	2.741	2.673
Main feed flow rate (kg/s)	-		2.7447	2.6701	2.7692	2.7244
SG downcomer water level (m)	9.22	9.19	9.251	9.273	9.251	9.271

* Case 1 : averaged U-tube model (regarded as Base Case)

* Case 2 : single broken U-tube and averaged U-tube model

Table 2 Setpoints and Conditions used in RELAP5/MOD3.1 Calculation

Events	Setpoints and Conditions
-Tube Break	-Break valve open at $t=0$
-Reactor Trip	- $P_{Pzr} < 13.42$ MPa -Experimental core power decay curve
-Main Feedwater Trip	- $P_{Pzr} < 12.97$ MPa
-Safety Injection Signal (SI)	- $P_{Pzr} < 12.87$ MPa
-Pump Coastdown	-Experimental coastdown curve
-IL RCP Restarted	-Rx Trip+3979s
-HPSI Flow rate	-Experimental pressure vs. flow rate curve
-HPSI into Cold legs	-Safety injection from SI+98s, plus charging
-HPSI into Core Upper Plenum	-Safety injection from SI+300s
-HPSI Turned off (stop)	-Pzr water level recovered - HPSI-CL: $L_{Pzr} > 1.0$ m - HPSI-UP: SI+2900s - Charging: no termination(0.265kg/s)
-Accumulator Injection	-Not used
-LPSI System	-Not used
-Aux. Feedwater Start	-BL: hot water: 1.14kg/s for 81s from SI+37s cold water: none -IL: hot water: 1.5kg/s for 200s from SI+37s cold water: 1.0kg/s from SI+237s until $L_{IL-SG} > 12.85$ m
-Affected SG Isolation	-BL-MSIV close from Rx Trip+722s
-Intact SG Depressurization	-IL-RV open from Rx Trip+722s
-Intact SG Depres. Termination	-IL-RV close if ($T_{IL-hotleg} < 531.4$ K)
-Affected SG RV Cycling	-6.4 MPa $< P_{BL-SGdome} < 7.3$ MPa
-SG Safety Valves Cycling	-7.69 MPa $< P_{BL-SGdome} < 8.68$ MPa
-Pzr. Aux. Spray Flow rate	-0.1 kg/s
-Pzr. Aux. Spray Start	-Rx Trip+2666s
-Pzr. Aux. Spray Turned off	- $P_{Pzr} = P_{IL-SGdome}$

Table 3 Event Sequences of SGTR Transient

Major Events (unit : second)	LSTF SB-SG-06	RELAP5/MOD3.1	
		(Case 1)	(Case 2)
- Tube Break	0	0	0
- Reactor Trip	266	251	246
- Main Feedwater Trip	300	280	280
- Safety Injection Signal	305	289	287
- Pzr. Empty	331	335	335
- Pump Coastdown	348	331	326
- Aux. Feedwater Start	342	326	324
- HPSI into Cold legs	403	387	385
- HPSI into Core Upper Plenum	605	589	587
- Affected SG Isolated(MSIV close)	988	973	971
- Intact SG Depressurized(RV open)	988	973	971
- Intact SG Depressurization Terminated (RV close)	1751	1744	1740
- Affected SG RV Opened	2635(once)	cycling	cycling
- Pzr. Aux. Spray Start	2932	2917	2915
- HPSI Turned off (stop)	3390	3390	3390
- Pzr. Aux. Spray Turned off	3617	3527	3742
- Intact Loop RCP Restarted	4245	4230	4225
- Termination	5000	5000	5000

* Case 1 : break nozzle model based on SB-SG-06 test configuration
(regarded as Base Case)

* Case 2 : break valve model with single averaged and broken U-tube

Table 4 Lists of Measured Data and Corresponding Calculated Parameters

Items	Origin of Measured Data	Full Scale Accuracy*	Calculated Parameters
-Primary pressure	Ref. 3 & 5	0.32 FS	p-610010000
-Secondary pressure	Ref. 3 & 5	0.32 FS	p-516010000, p-316010000
-Core inlet temperature	not used	-	tempf-120010000
-Core mid temperature	Ref. 5	0.616 FS	tempf-124030000
-Core outlet temperature	not used	-	tempf-128010000
-RCS saturation temperature	Ref. 3 & 5	0.777 FS	sattemp-200010000
-Steam dome steam temperature	unavailable	-	tempg-516010000
-SG saturation temperature	unavailable	-	sattemp-516010000
-SG water temperature	unavailable	-	tempf-504040000
-Intact loop hot leg temperature	Ref. 5	0.616 FS	tempf-206010000
-Broken loop hot leg temperature	Ref. 5	0.616 FS	tempf-406010000
-Pzr water level	Ref. 5	0.32 FS	cntrlvar 610
-SG water level	Ref. 3	0.32 FS	cntrlvar 312, 512
-Intact loop mass flow rate	Ref. 5	1.12 FS	mflowj-206020000
-Broken loop mass flow rate	Ref. 5	1.12 FS	mflowj-406020000
-HPSI-up mass flow rate	Ref. 5	1.62 FS	mflowj-722000000
-HPSI-cold legs mass flow rate	Ref. 5	1.62 FS	cntrlvar 922
-Break mass flow rate	Ref. 5	1.12 FS	cntrlvar 916
-Integrated break & HPSI flow	unavailable	-	cntrlvar 915, 921
-Intact SG feedwater flow rate	unavailable	-	cntrlvar 917
-Broken SG feedwater flow rate	unavailable	-	cntrlvar 918
-Pzr aux spray mass flow rate	unavailable	-	mflowj-612000000
-Steam dump flow rate	unavailable	-	mflowj-369000000
-Heat flux on U-tube wall	unavailable	-	htrnr-420100101
-Heat flux on steam dome wall	unavailable	-	htrnr-500300400
-Flow rate in Pzr surge line	unavailable	-	mflowj-206040000
-Void fraction in Pzr surge line	unavailable	-	voidg-600030000

* Detailed Information was described in Ref. 2

Table 5 Comparison of Integrated Total Mass Flows during Transient

Mass Flows (unit : kg)	LSTF SB-SG-06	Case 1	Case 2 (RELAB5/MOD3.1)		
			C _d =0.15	C _d =0.18	C _d =0.20
- Total break flow into secondary side	about 2600	3177	3212	3482	3765
- Total HPSI flow into RCS (up/cl)	about 2900 (1000/1900)	3497 (1216/2281)	3535	3947 (1373/2574)	4248
- Discharged steam flow through MSL	about 1200	1277	-	1185	-
- Discharged steam flow through RV	about 20	133	-	153	-
- Aux. Feedwater flow into SG	about 500	669	-	605	-

* Case 1 : break nozzle model based on SB-SG-06 test configuration

* Case 2 : break valve model with single averaged and broken U-tube

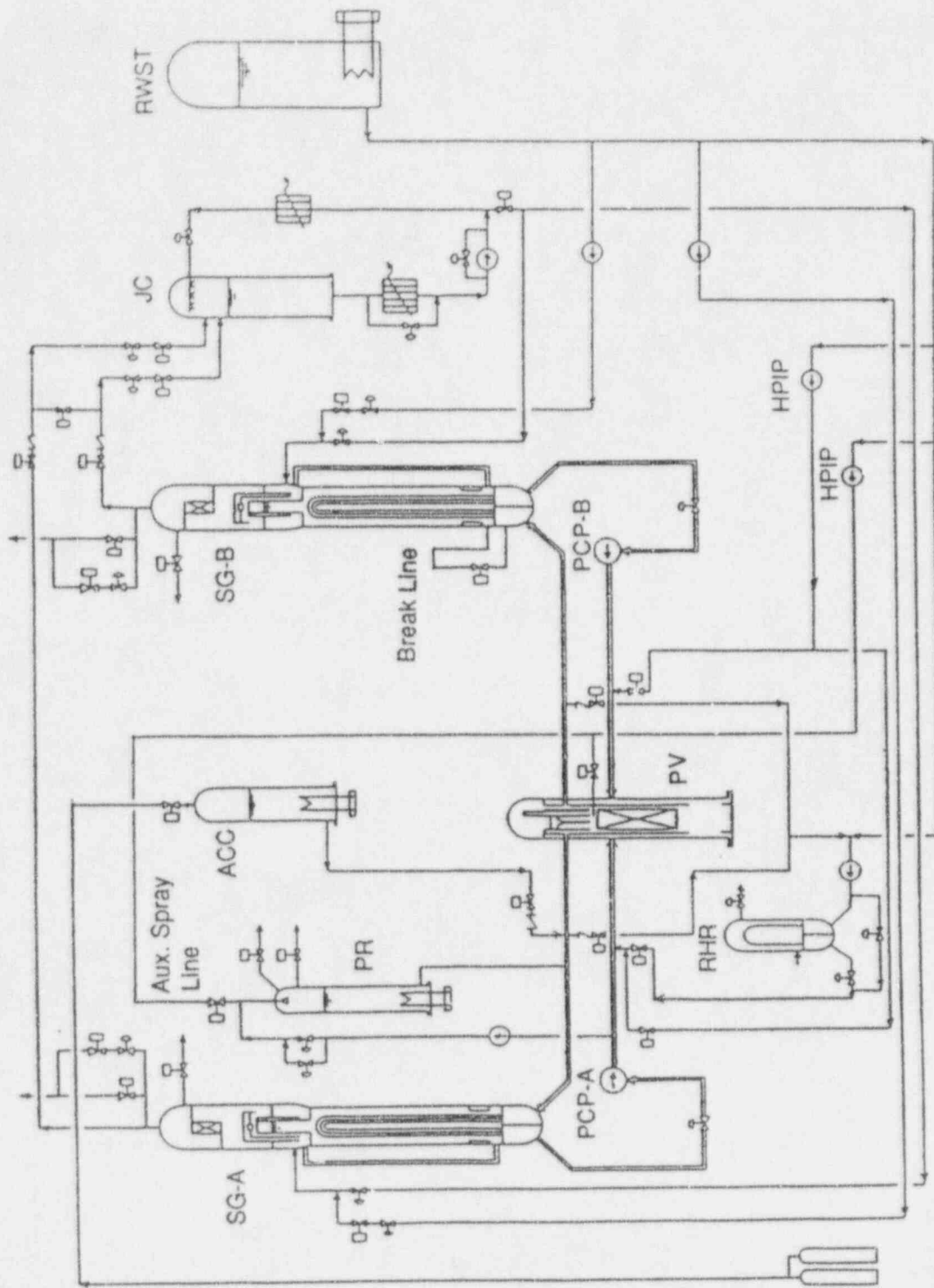


Figure 1 ROSA-IV LSTF Flow Diagram

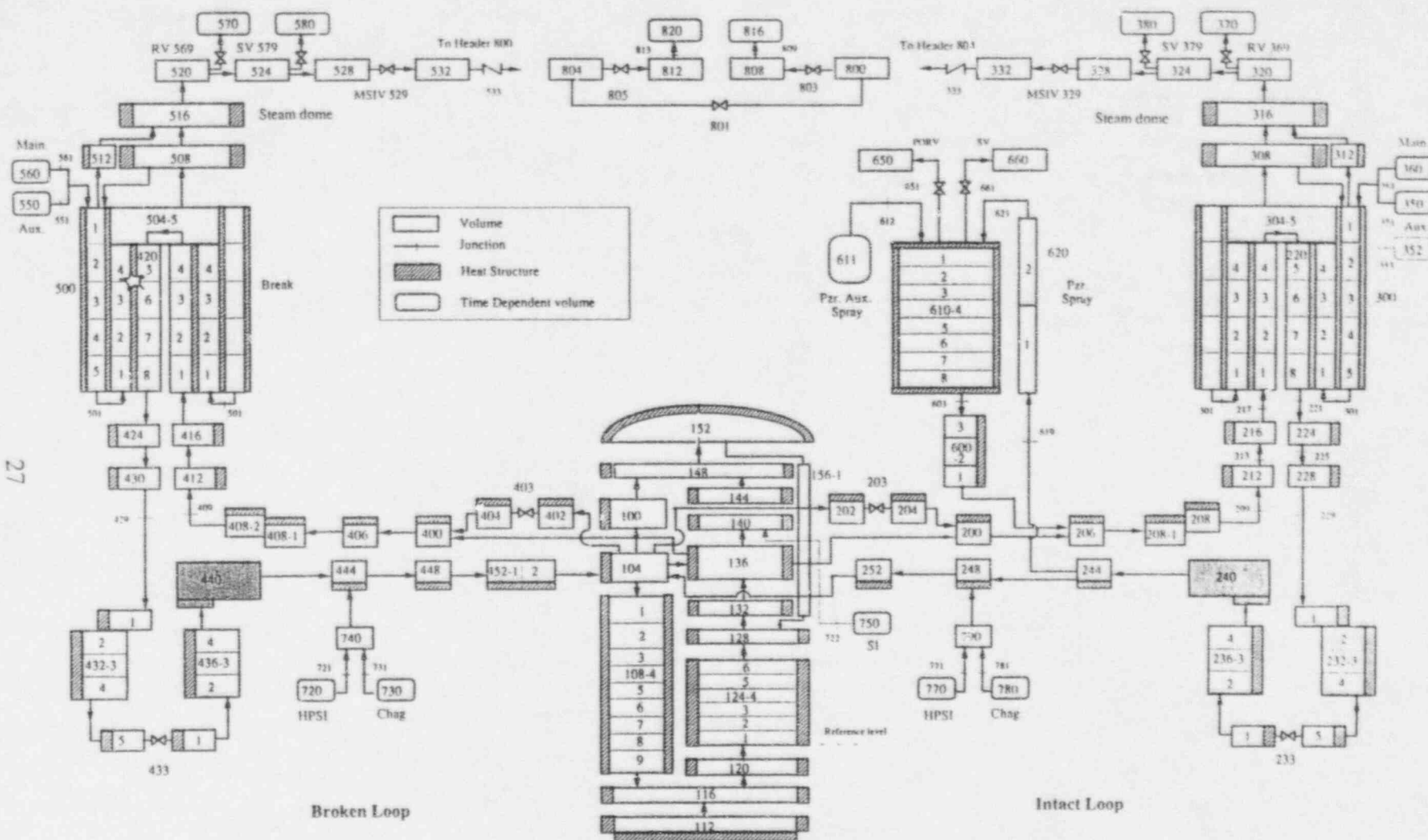
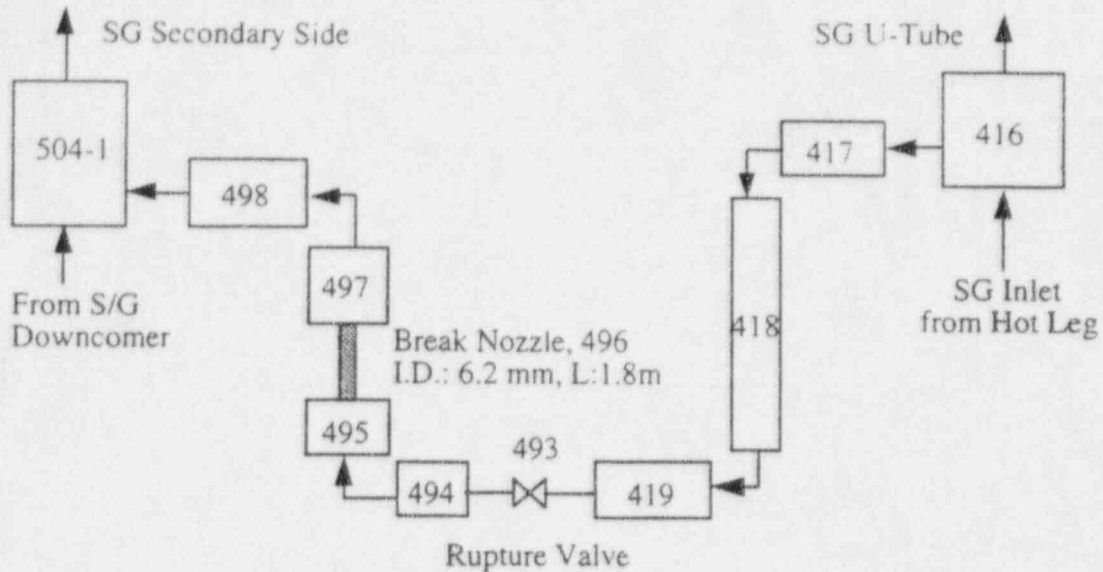


Figure 2 RELAP5 Nodalization of ROSA-IV LSTF for SGTR Transient Assessment

(1) Case 1 (Base Case): Break Nozzle Model Based on Facility Configuration



(2) Case 2 : Break Valve Model with Single Averaged and Broken U-Tube

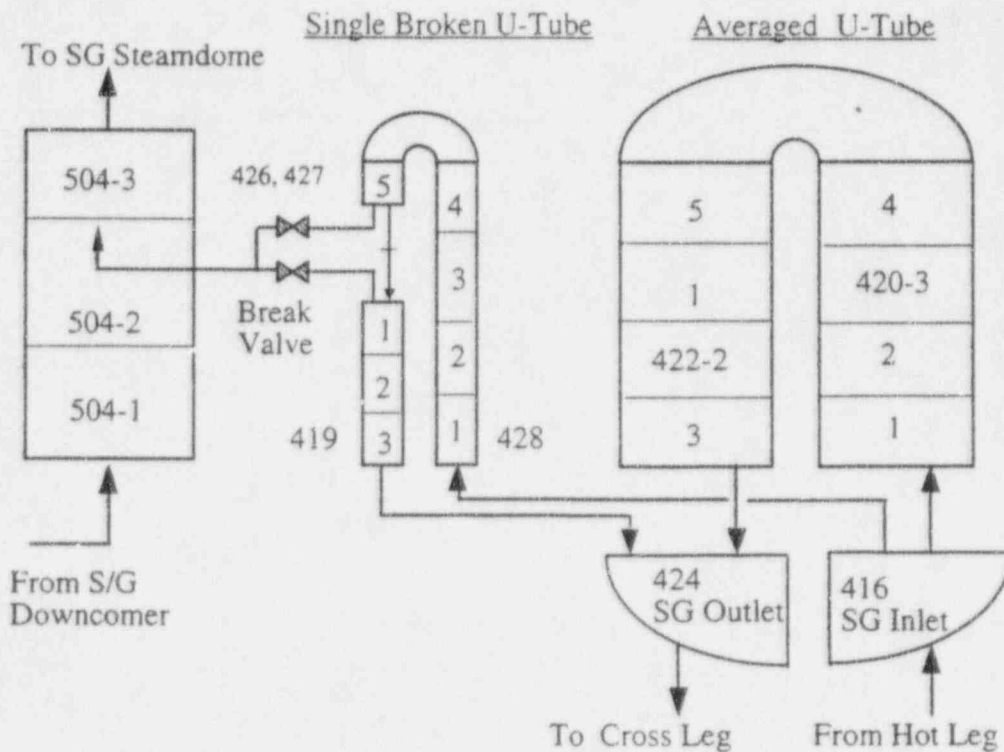


Figure 3 Break Simulation and Nodalization

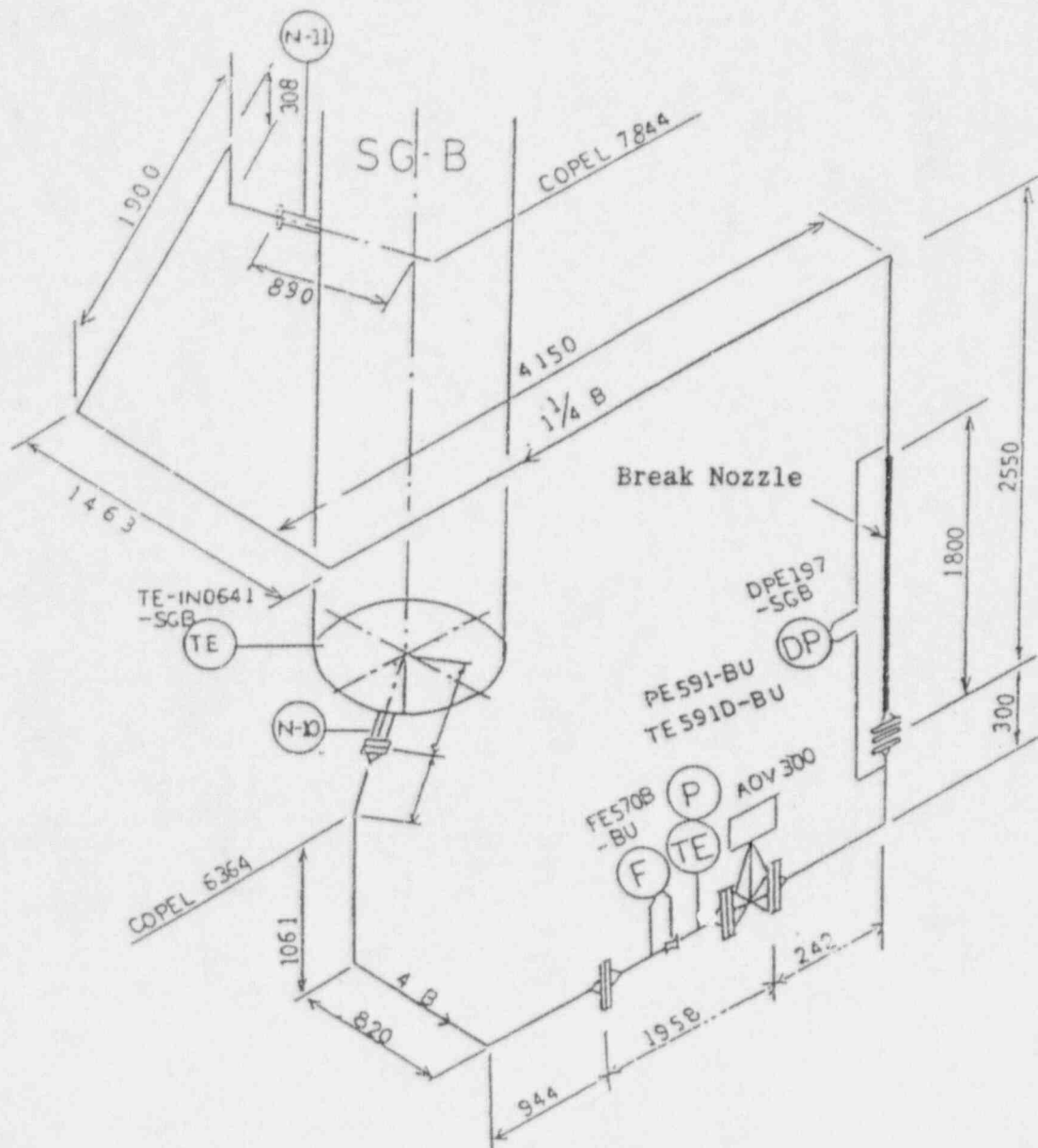


Figure 4 Break Line Configuration in LSTF SB-SG-06 Test

Figure 5 Comparison of Primary Pressure between Experiment and Calculation

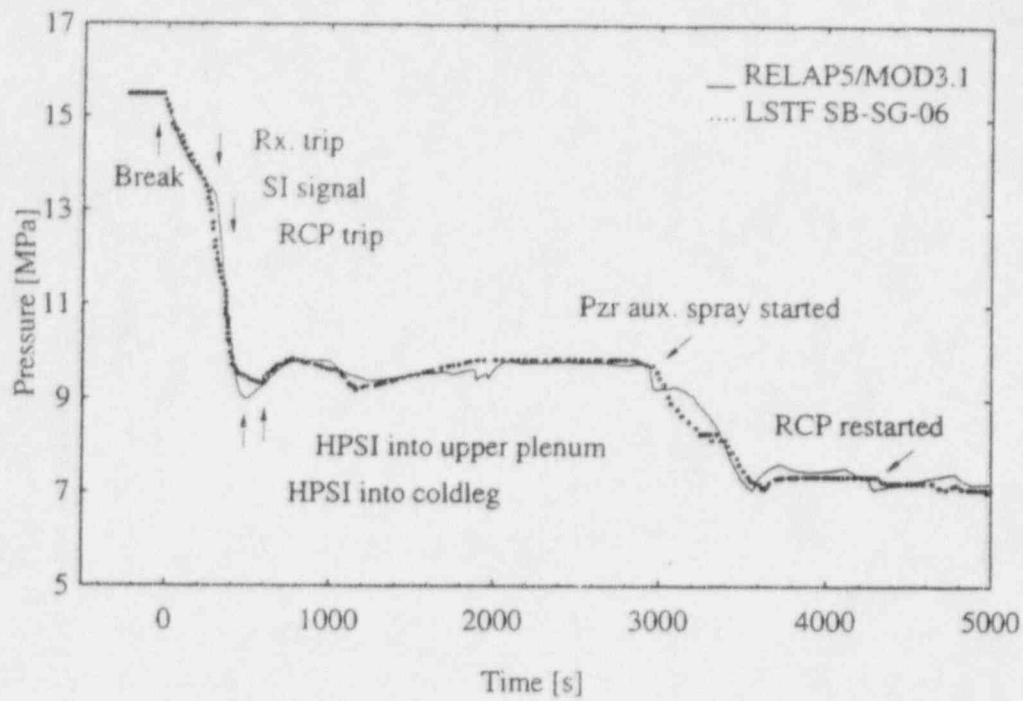


Figure 6 Comparison of Secondary Pressures between Experiment and Calculation

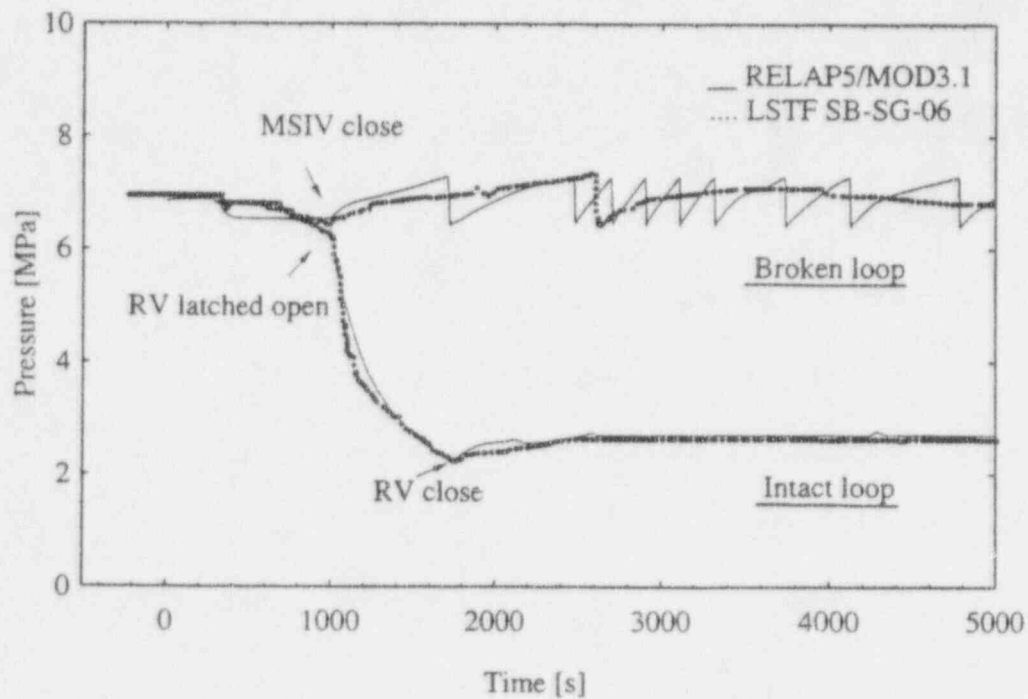


Figure 7 Comparison of Core Fluid Temperatures

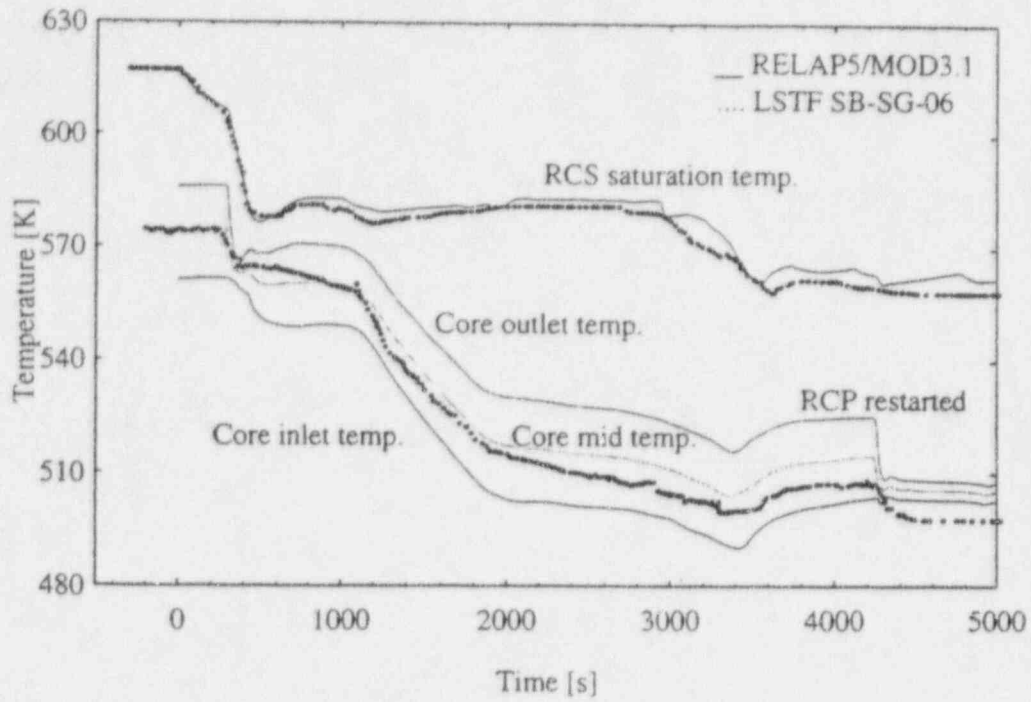


Figure 8 Comparison of Broken Loop Secondary Side Fluid Temperatures

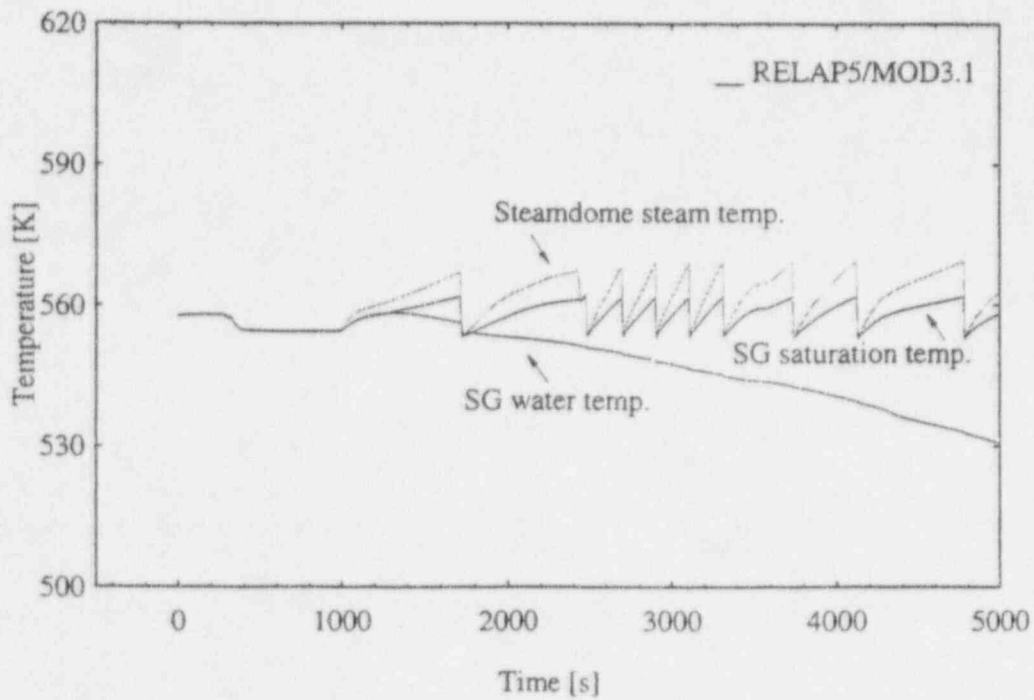


Figure 9 Comparison of Intact Loop Hot leg Temperature

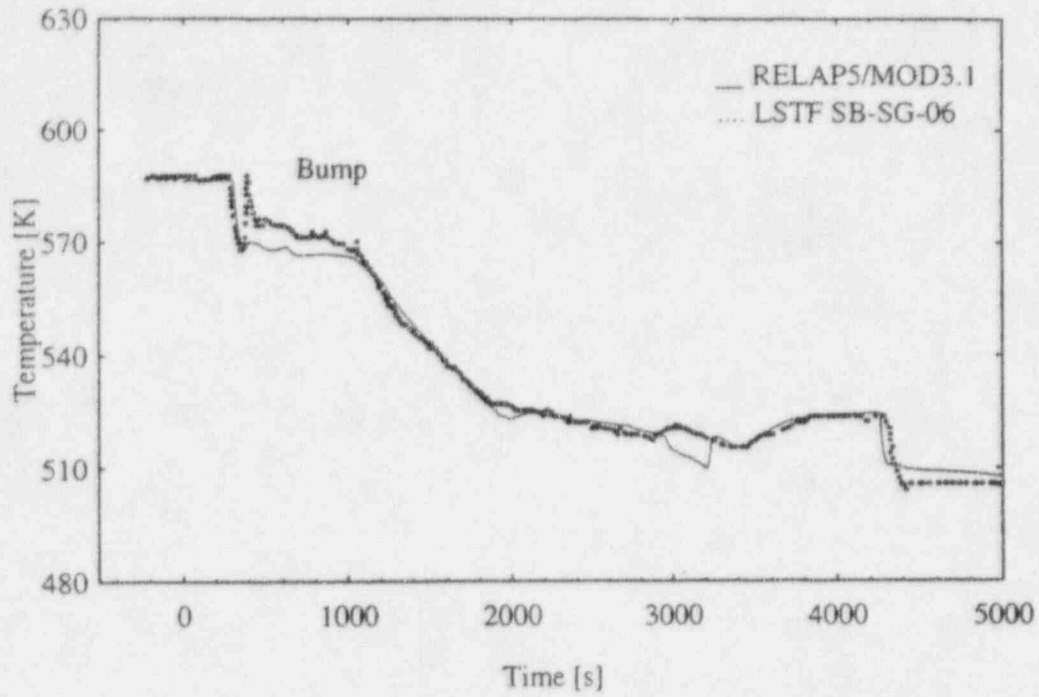


Figure 10 Comparison of Broken Loop Hot leg Temperature

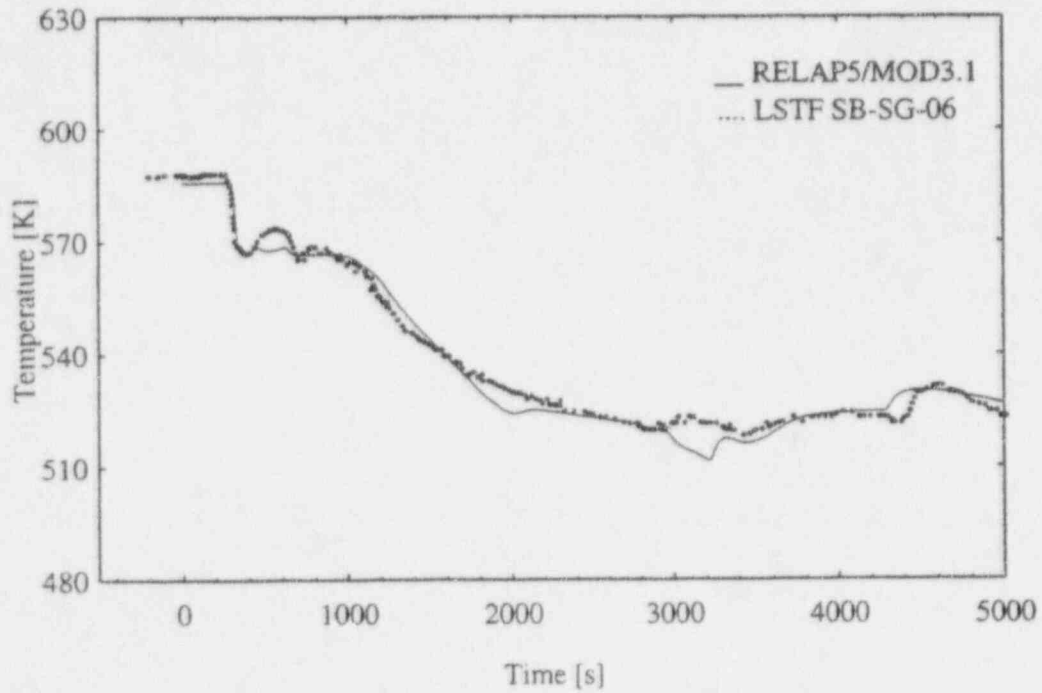


Figure 11 Comparison of Pressurizer Water Level

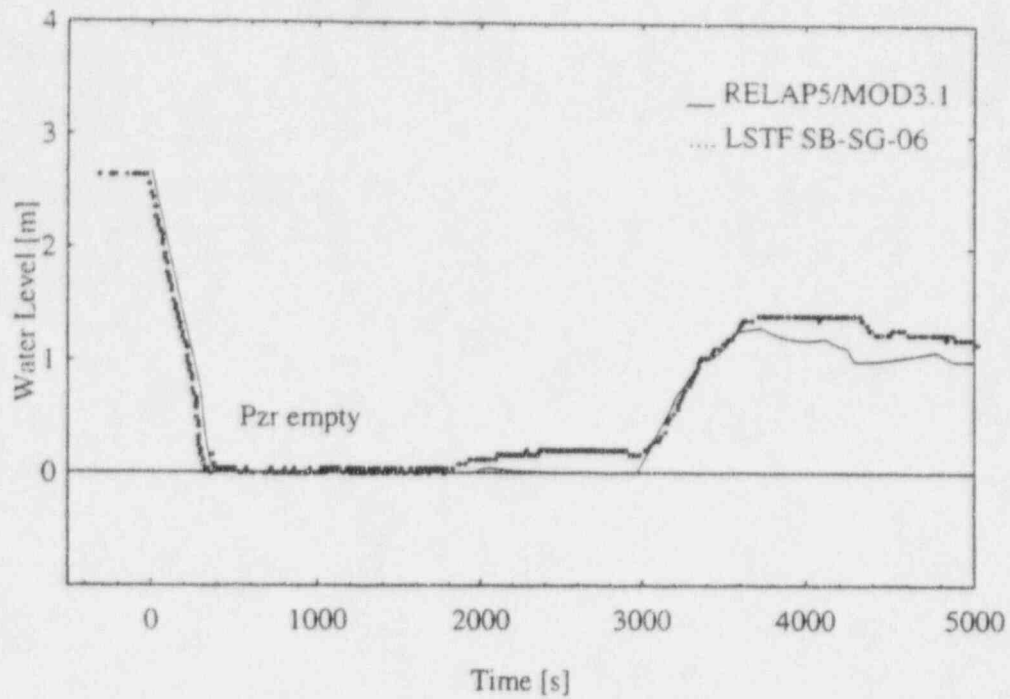


Figure 12 Comparison of SG Water Levels

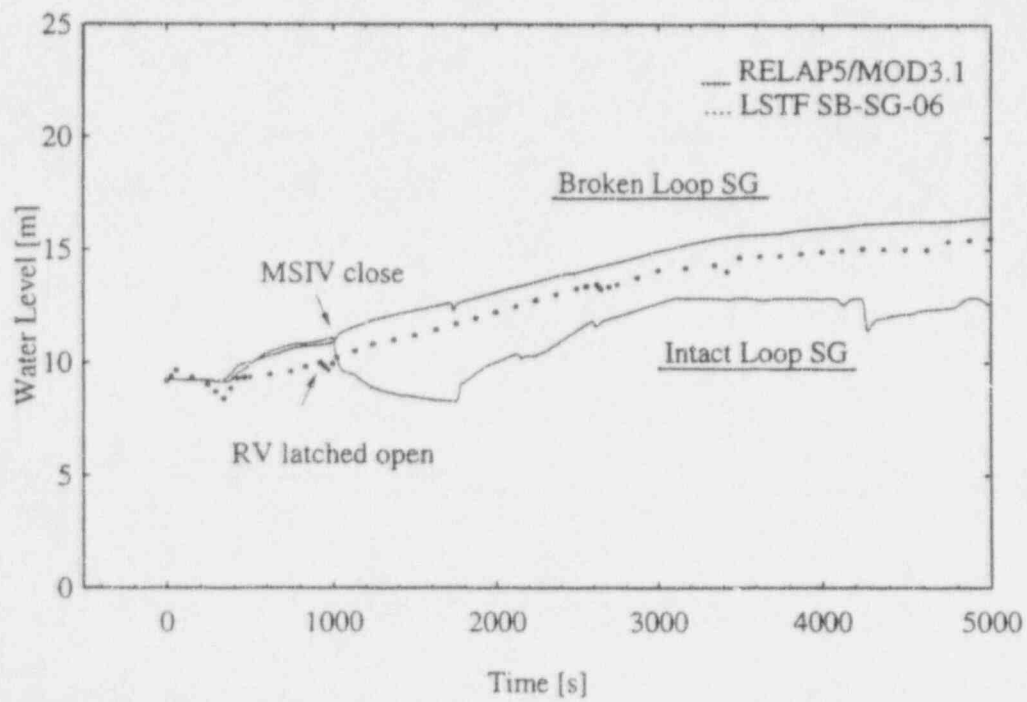


Figure 13 Comparison of Intact Loop Mass Flow rate

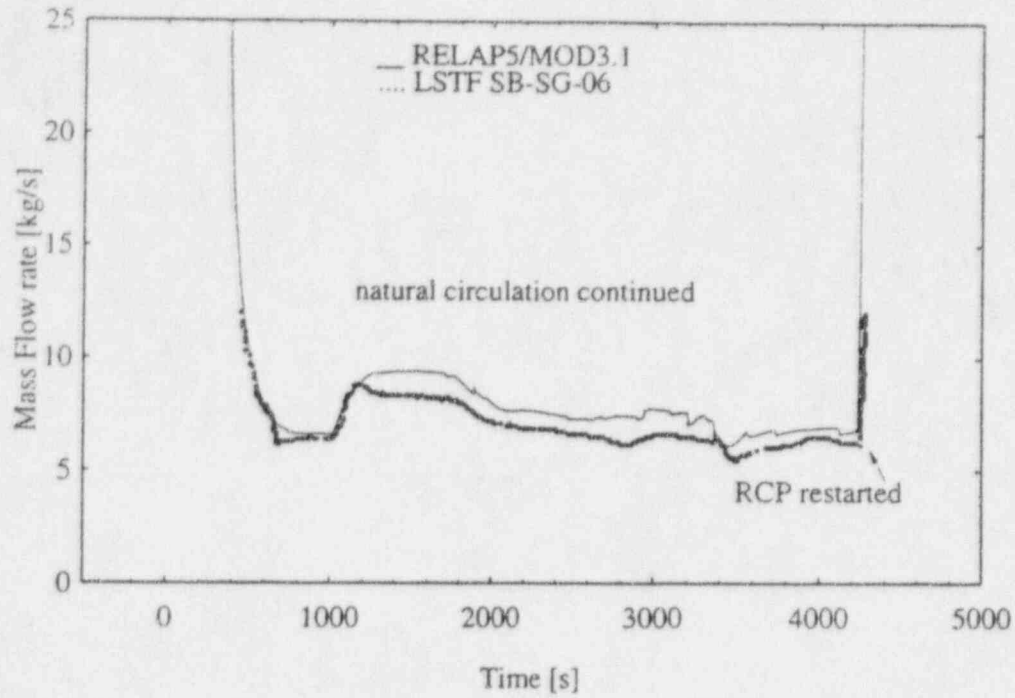


Figure 14 Comparison of Broken Loop Mass Flow rate

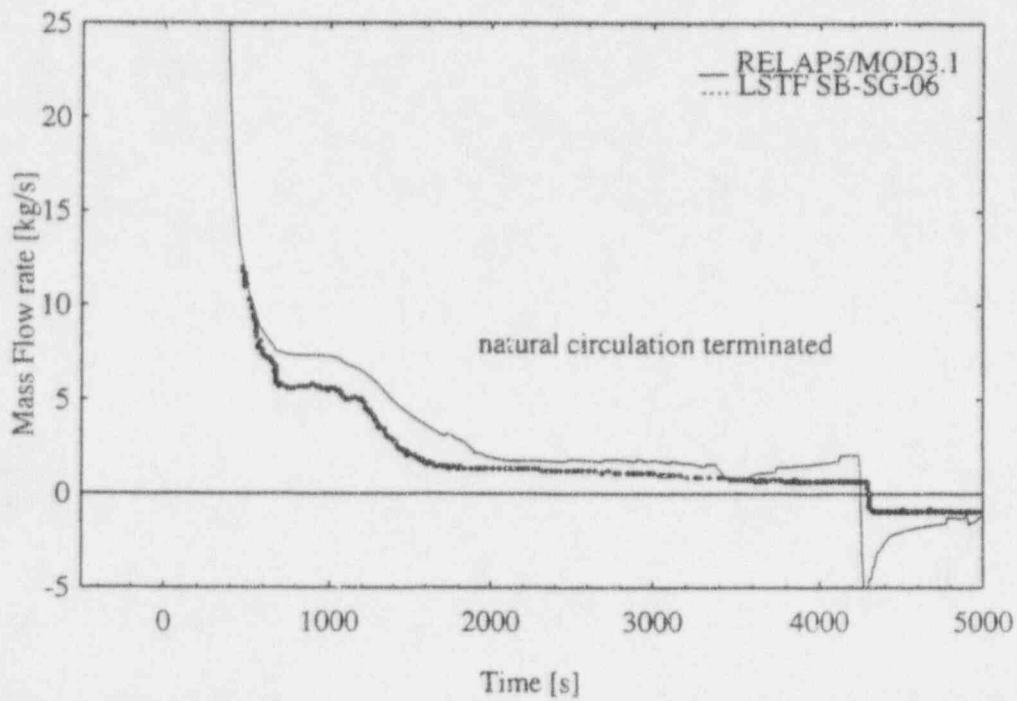


Figure 15 Comparison of HPSI-core upper plenum Mass Flow rate

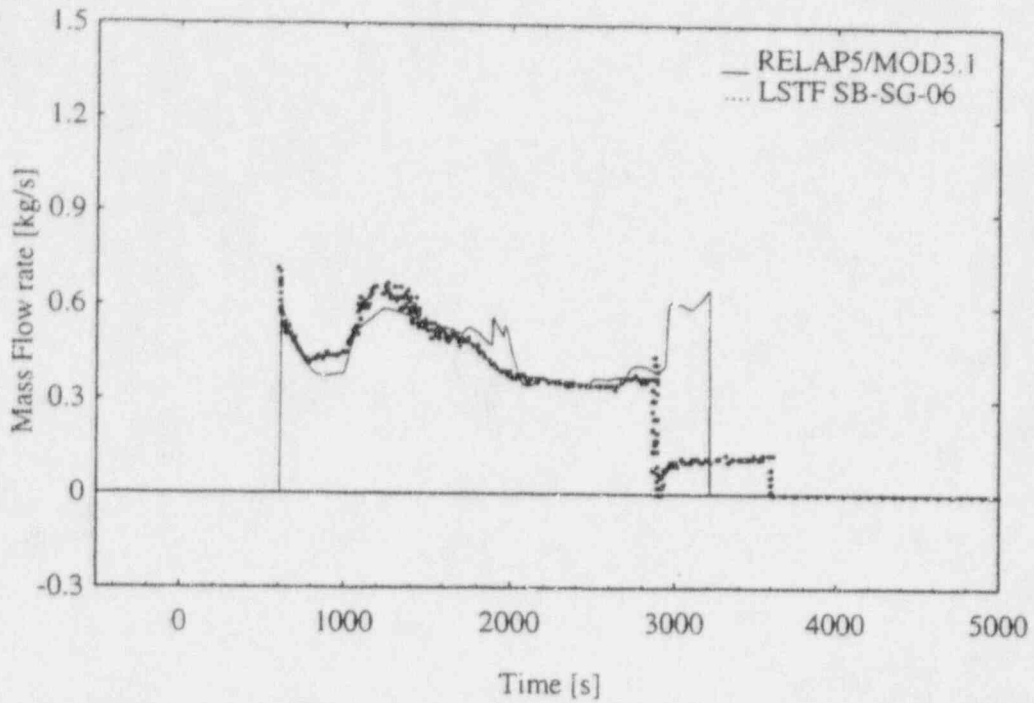


Figure 16 Comparison of HPSI-cold legs Mass Flow rate

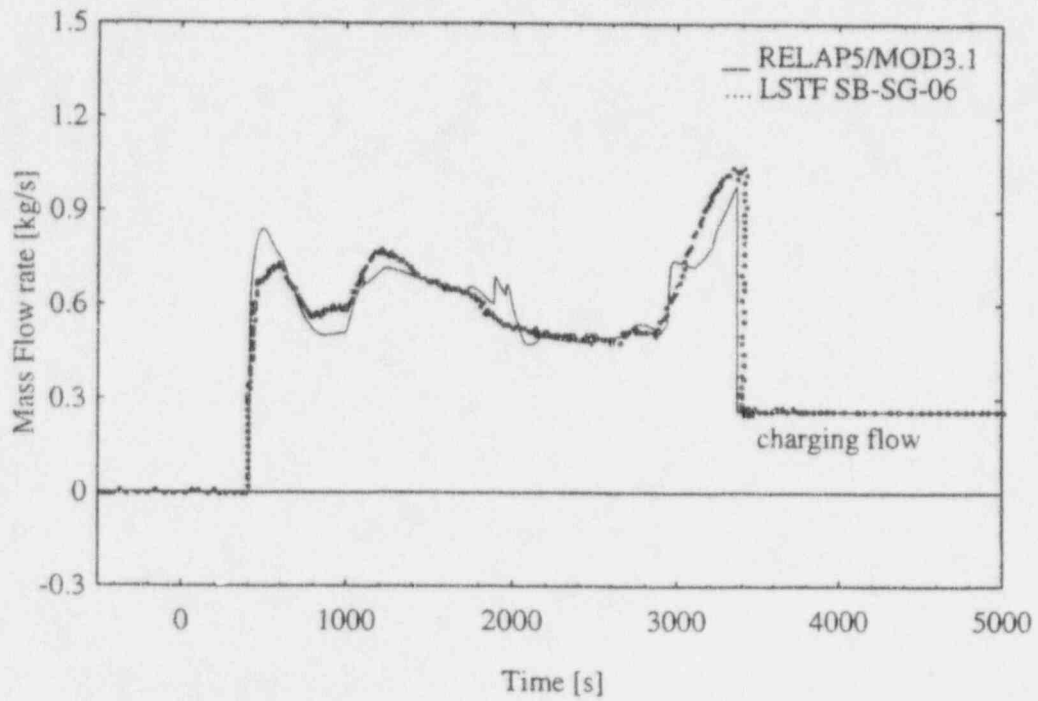


Figure 17 Comparison of Break Mass Flow rate between Experiment and Calculation

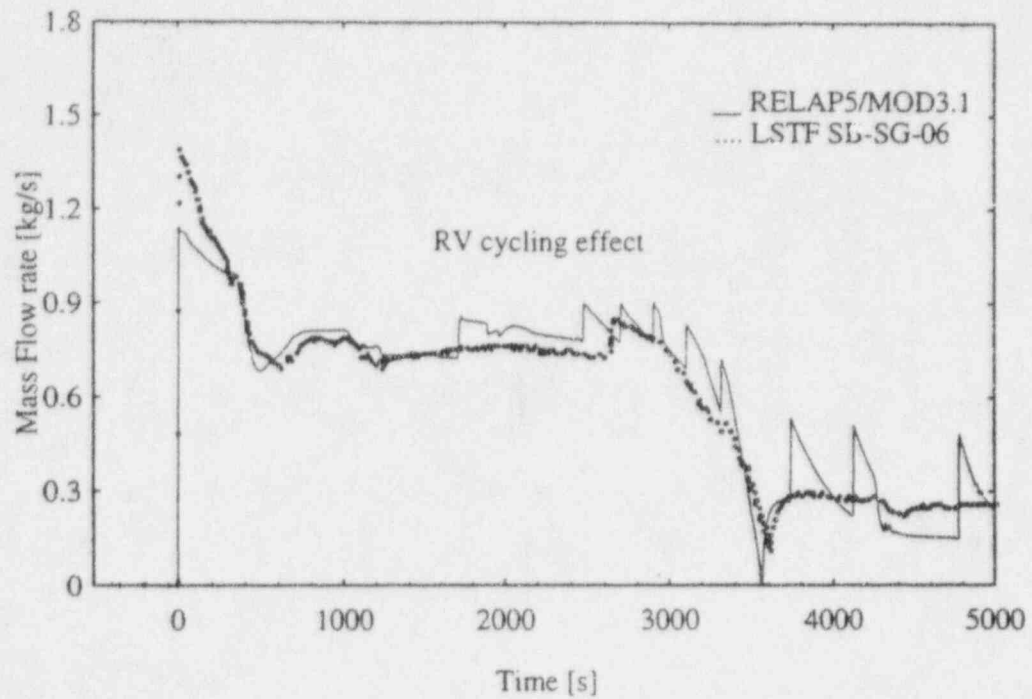


Figure 18 Integrated Break Mass Flow and HPSI Mass Flow

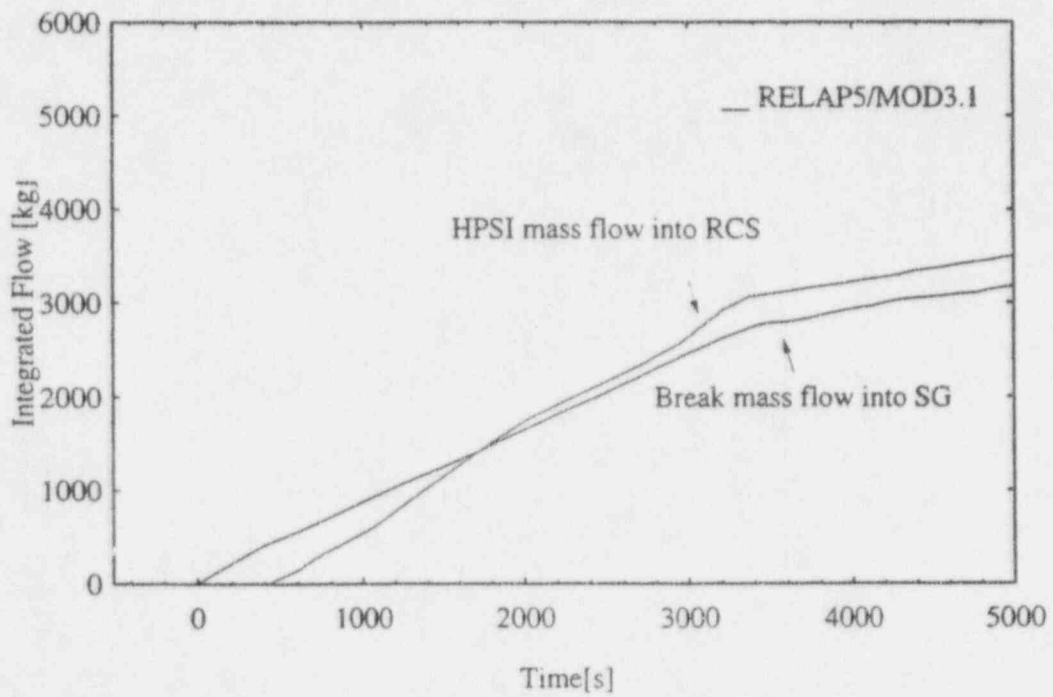


Figure 19 The Calculated Feedwater Flow rate in Intact Loop Secondary Side

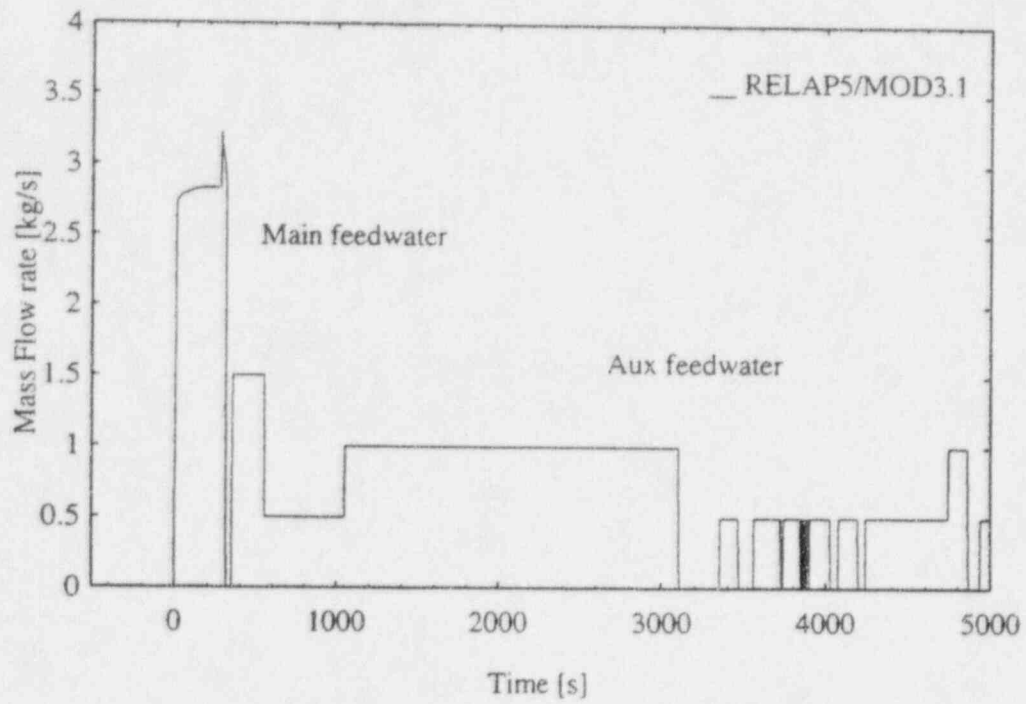


Figure 20 The Calculated Feedwater Flow rate in Broken Loop Secondary Side

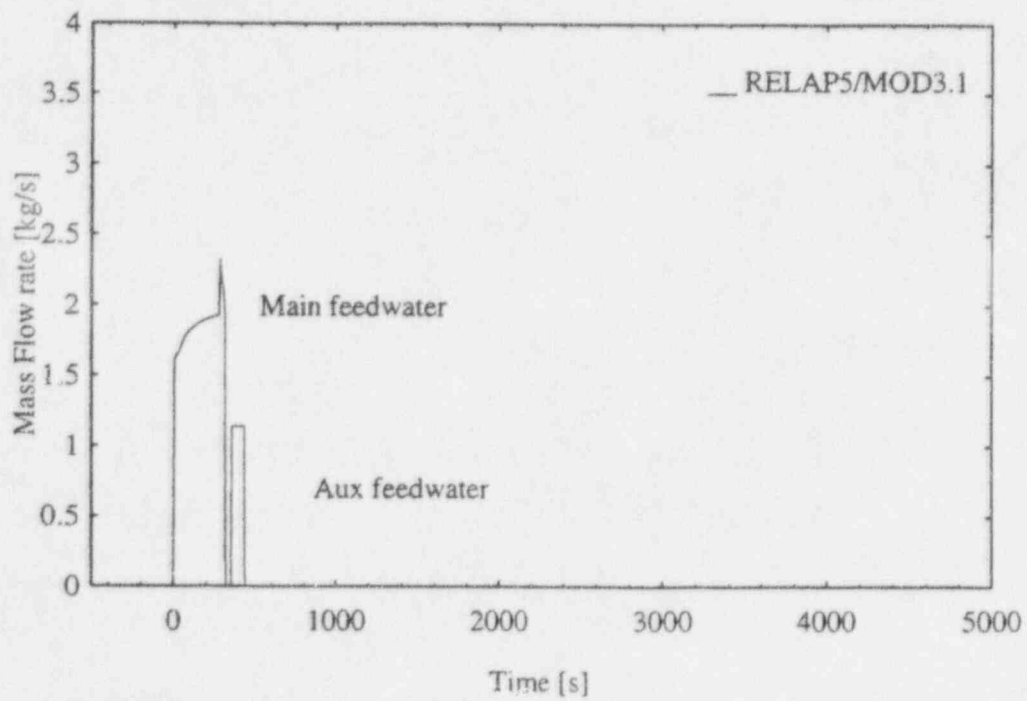


Figure 21 The Pressurizer Auxiliary Spray Mass Flow rate

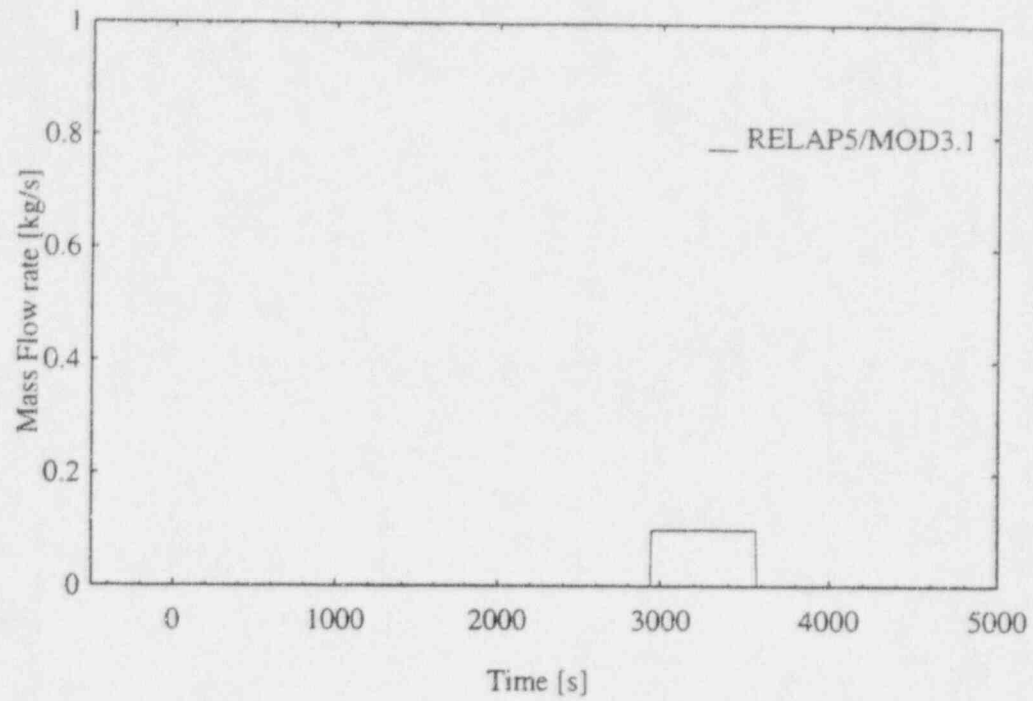


Figure 22 The Atmospheric Steam Dump Flow rate through Intact Loop Relief Valve

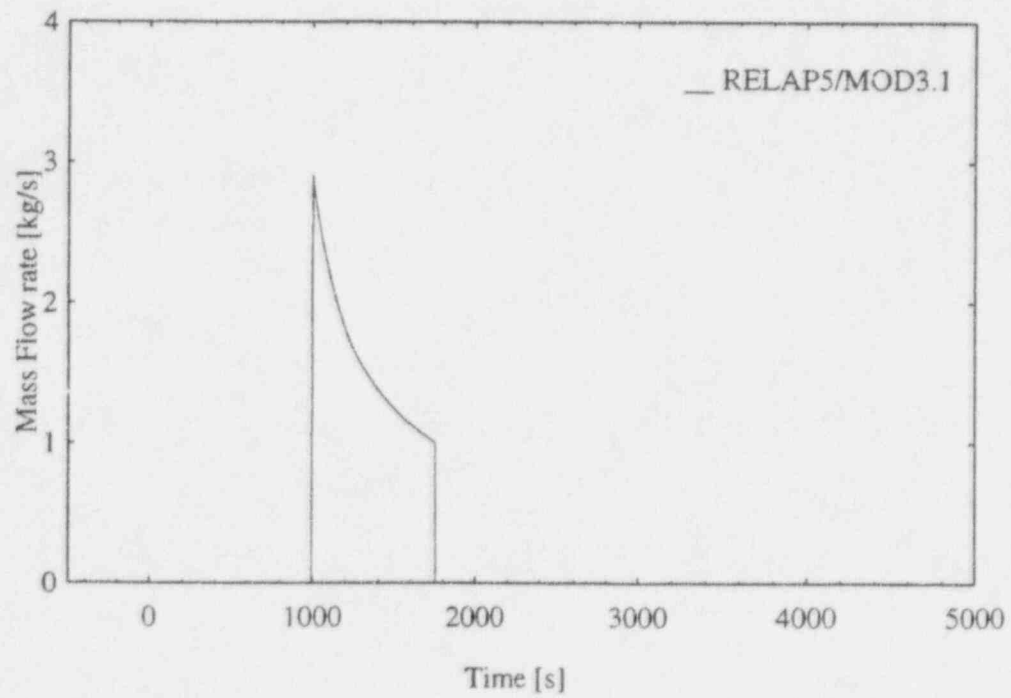


Figure 23 The Calculated Heat Flux on U-tube Wall in Broken Loop SG

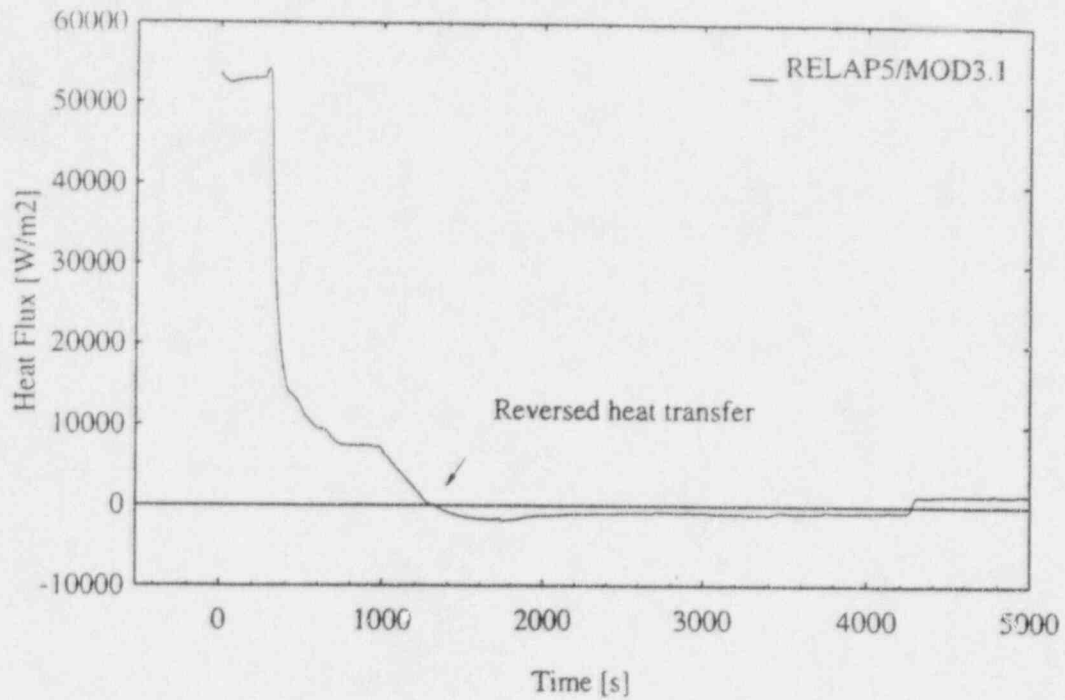


Figure 24 The Calculated Heat Flux on Steamdome Wall in Broken Loop SG

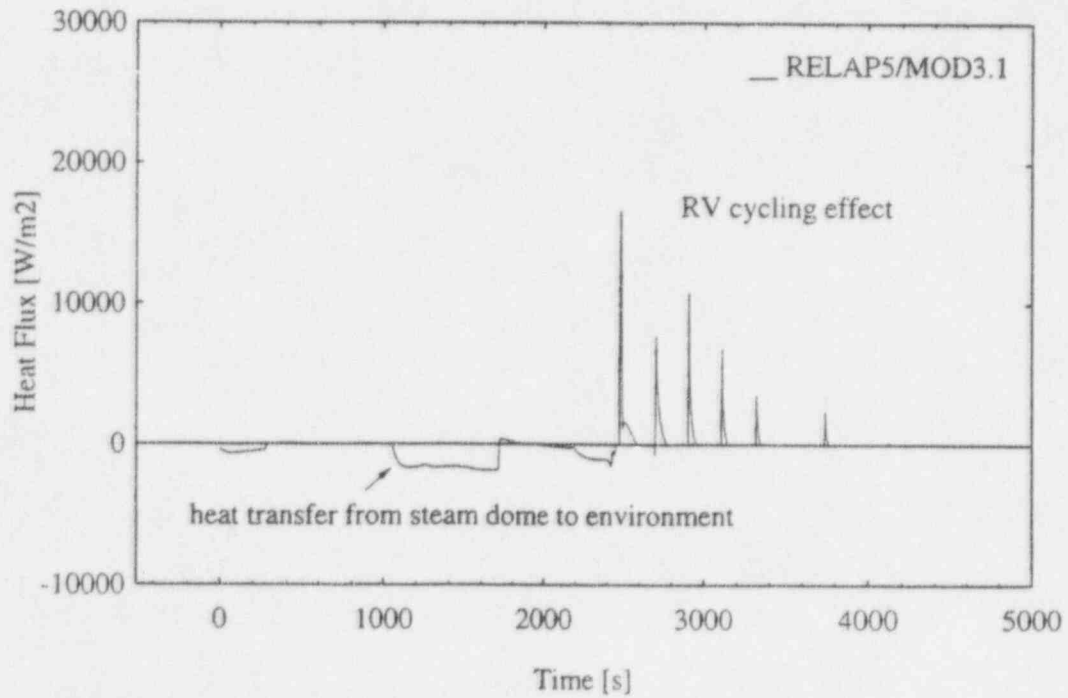


Figure 25 The Calculated Flow rate on Pressurizer Surge Line

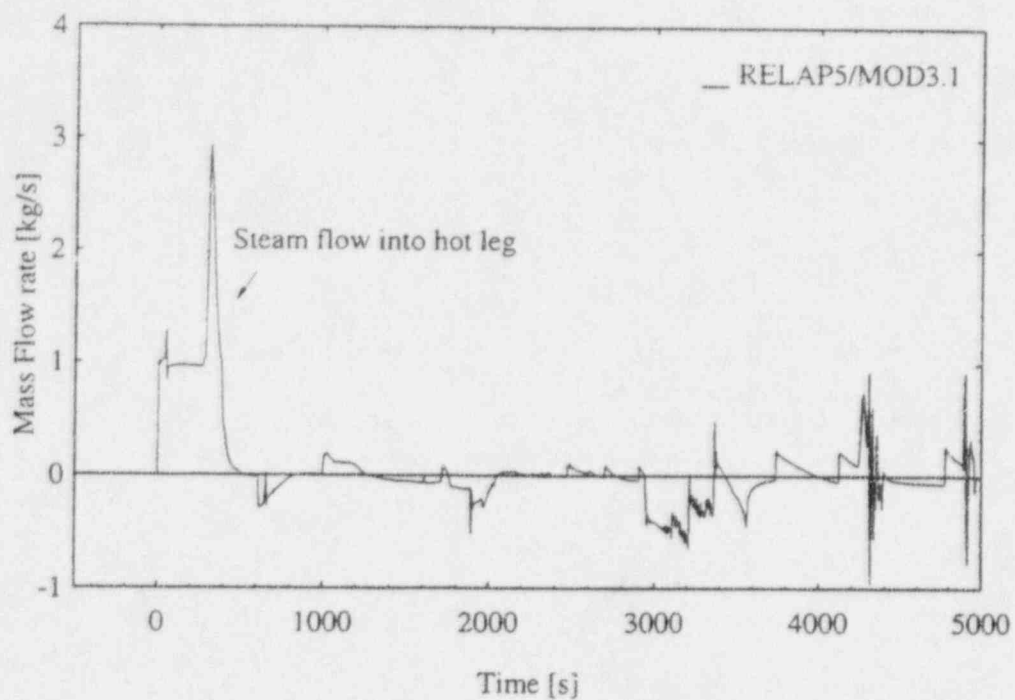


Figure 26 The Calculated Void Fraction in Pzr Surge Line and Hot Leg

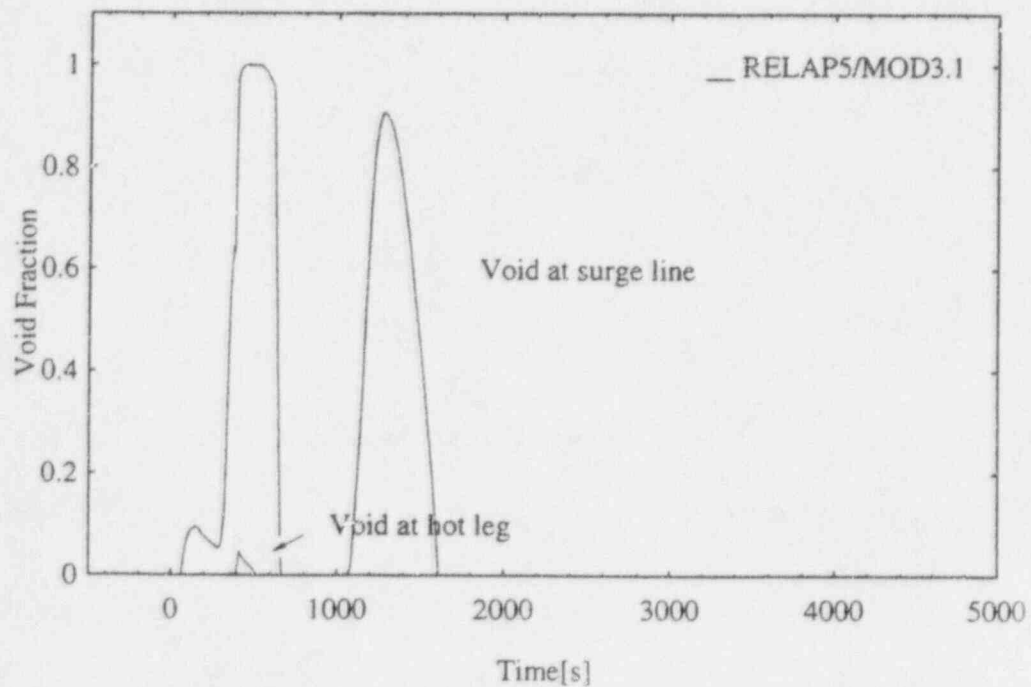


Figure 27 Comparison of Primary Pressure between MOD3.0 and MOD3.1

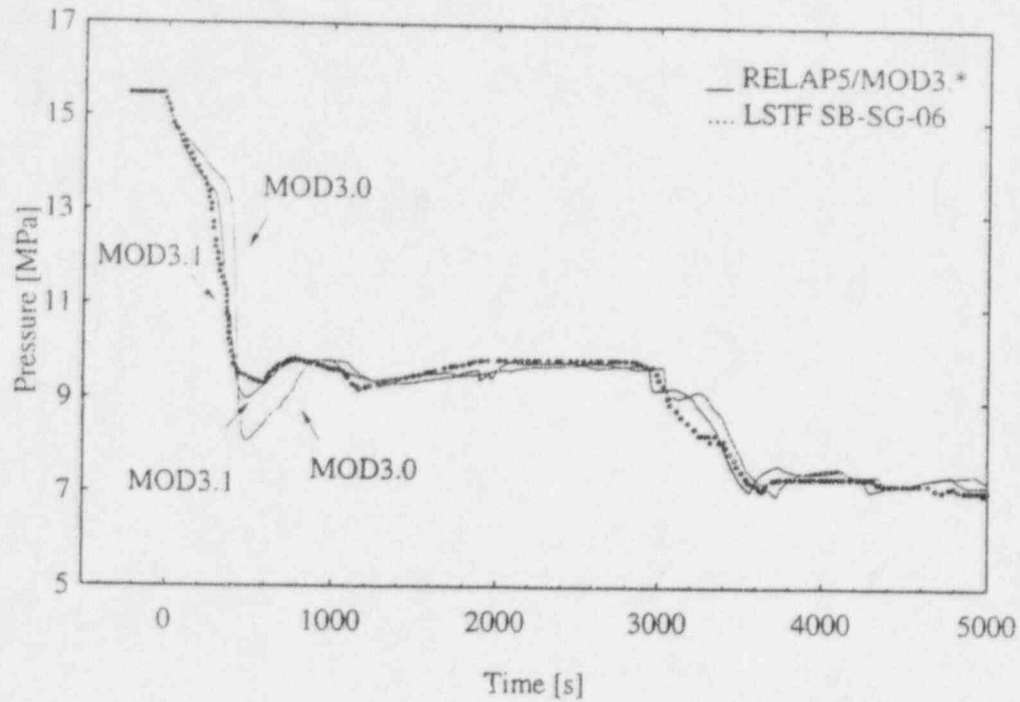


Figure 28 Comparison of Break Mass Flow rates on Break Simulation Model

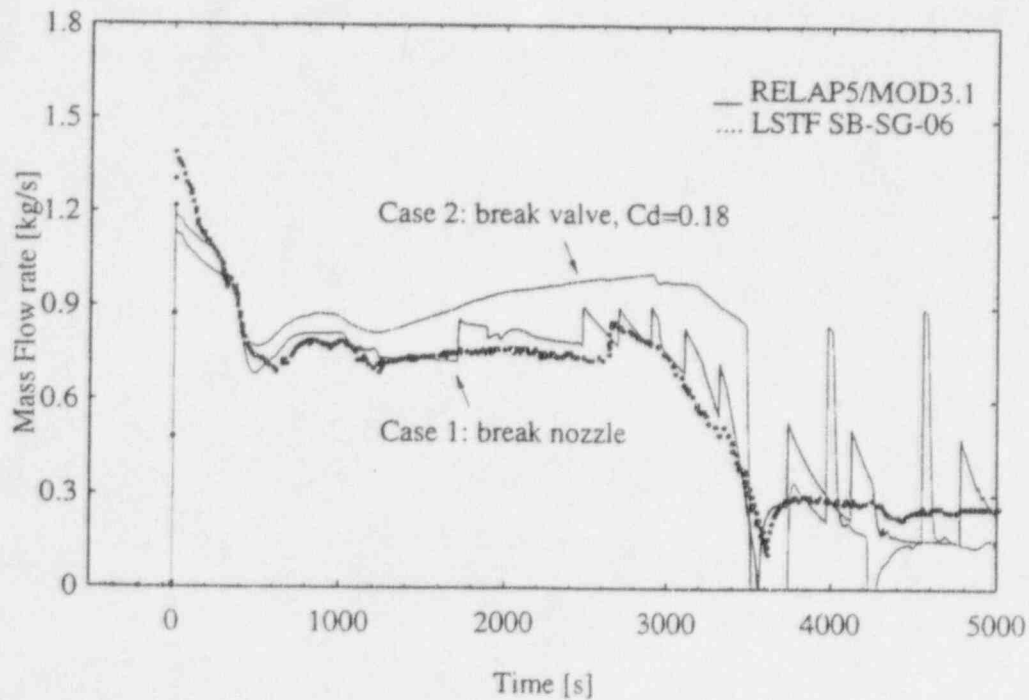


Figure 29 Comparison of Break Mass Flow rates on Break Discharge Coefficient

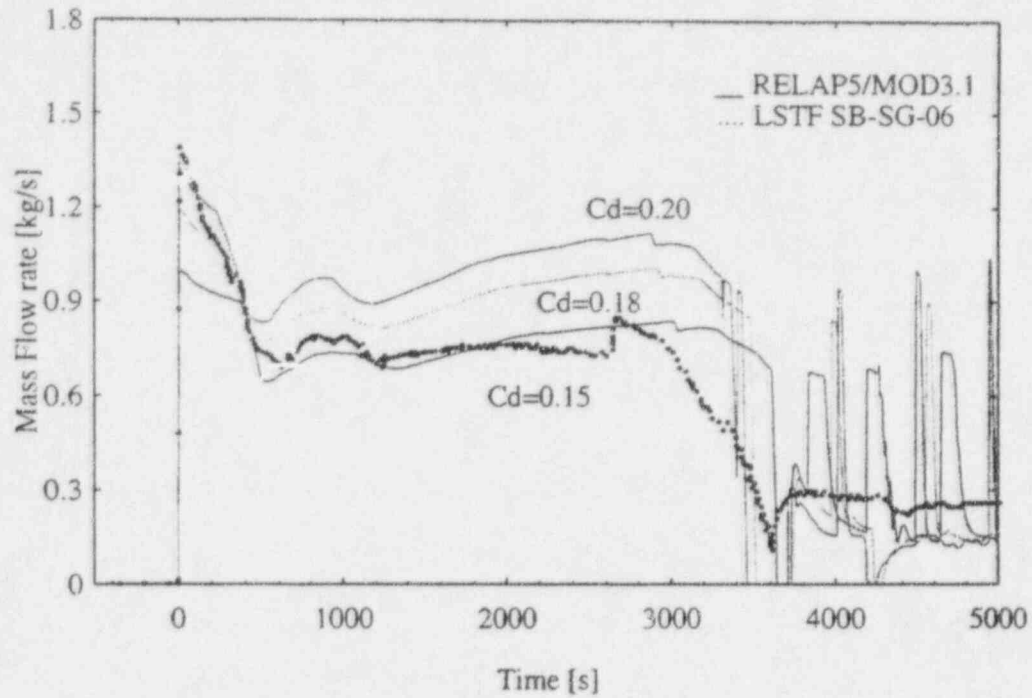


Figure 30 Comparison of CPU Times

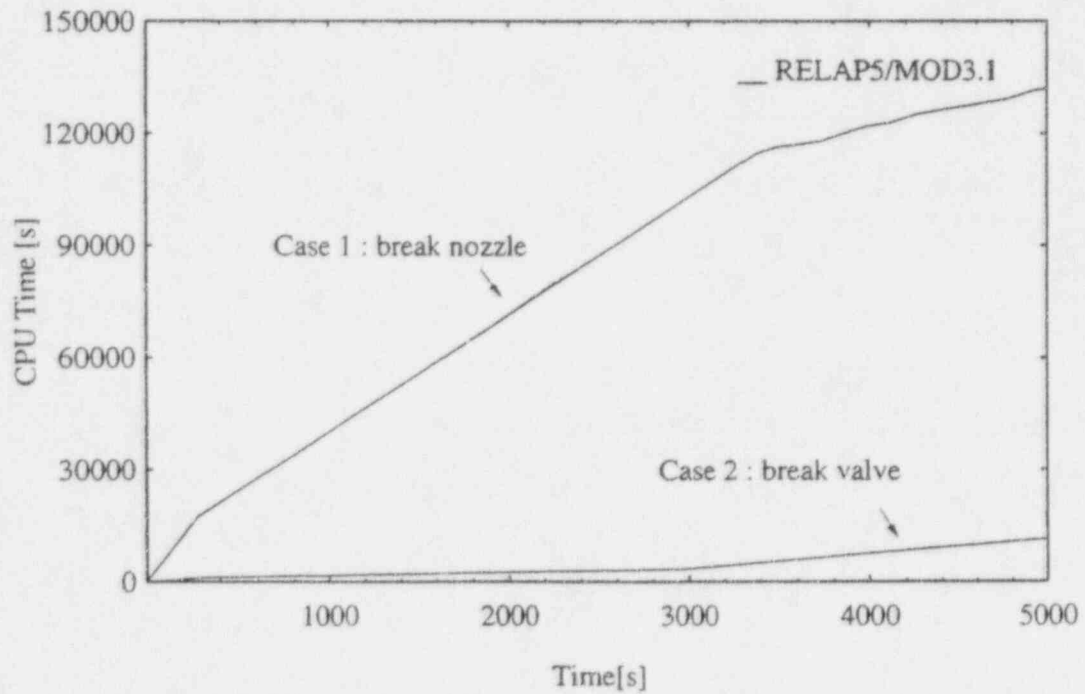
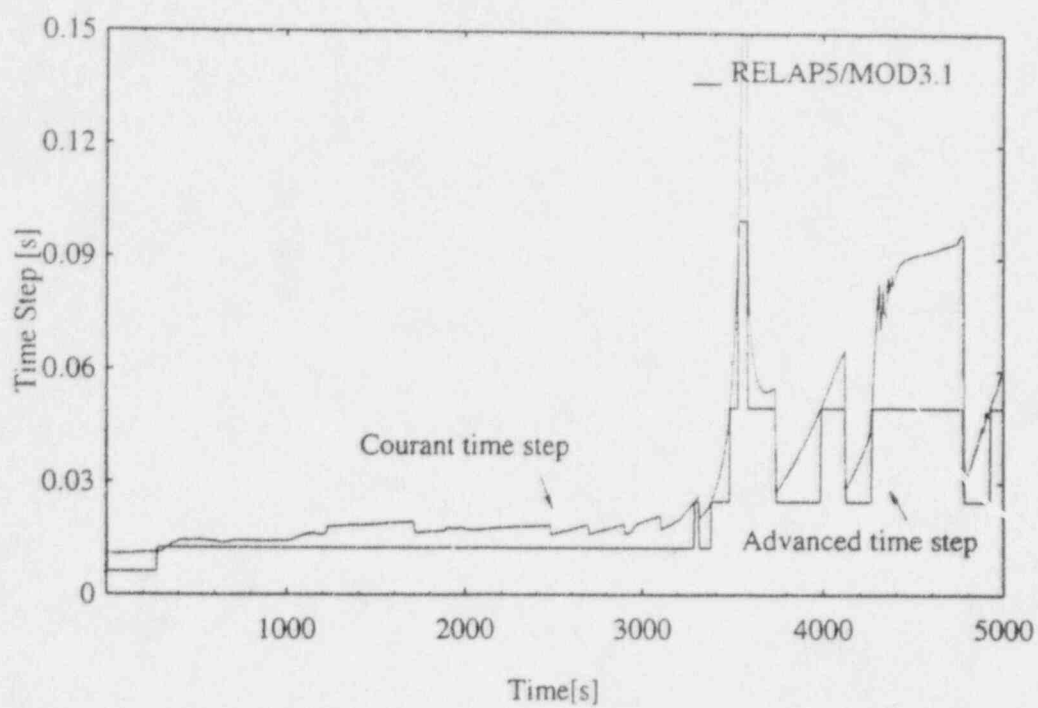


Figure 31 Courant Time Step and Advanced Time Step Size



Appendix A Input Deck for Steady State Calculation

```

*****
*
= lstf sgtr base input deck with relap5/mod3.1
*
*****
*
0000100      new      stdy-st
*
0000101      run
0000102      si      si
0000105      1.0    2.0
*
0000110      nitrogen
0000115      1.0
*
0000120      124010000  0.00  h2o  primary
*0000121      504010000  7.9639 h2o  secndry
C000121      900010000  0.00  h2o  contain
*
* time step control
*
0000201      3000.0  1.0-6  0.5  3  10  200  200
*
*****
* minor edits
*****
*
301 p      610010000  *pzz pressure
302 p      516010000  *sg-b steam pressure
303 p      316010000  *sg-i steam pressure
304 mflowj  208010000  *loop-i hot leg flow
305 mflowj  408010000  *loop-b hot leg flow
306 mflowj  248010000  *loop-i cold leg flow
307 mflowj  452010000  *loop-b cold leg flow
308 mflowj  108010000  *core bypass flow
309 mflowj  120010000  *core inlet flow
310 tempf   104010000  *vessel inlet temp
311 tempf   136010000  *vessel outlet temp
312 tempf   120010000  *core inlet temp
313 tempf   128010000  *core outlet temp
314 tempf   316010000  *sg-i steam temp
315 tempf   516010000  *sg-b steam temp
316 pmpvel   240
317 pmphead  240
318 pmpvel   440
319 pmphead  440
320 cntrlvar 512      *sg-b wr level
321 cntrlvar 508      *sg-b nr level

```

```

322 cntrlvar 504      *sg-b boiling water level
323 cntrlvar 312      *sg-i wr level
324 cntrlvar 308      *sg-i nr level
325 cntrlvar 304      *sg-i boiling water level
326 cntrlvar 610      *pzz level
327 cntrlvar 720      *primary mass
328 cntrlvar 309      *sg-i mass
329 cntrlvar 509      *sg-b mass
*

```

```

*****
* variable trips
*****

```

```

*
0000501 p      610010000  lt  null 0 1.342e+7 1 *rx scram signal
0000502 time      0 ge  null 0 1.e6 1 *power
0000505 p      610010000  lt  null 0 1.287e+7 1 *rcp&si
0000506 time      0 ge  timeof 505 17.0 1 *lpsi delay
0000507 time      0 ge  null 0 1.0e6 n *rcp delay
0000510 time      0 ge  timeof 505 10.0 1 *il hpi
0000511 time      0 ge  timeof 505 300.0 1 *il hppi to up
0000512 time      0 ge  timeof 505 10.0 n *bl hpi
0000514 cntrlvar 30 ge  cntrlvar 31 0.0 n *mean temp
0000516 cntrlvar 30 lt  cntrlvar 31 0.0 n
0000520 p      610010000  ge  null 0 1.646e+7 1 *high pres
0000522 p      610010000  ge  null 0 1.726e+7 n *pzz sfty
0000524 p      610010000  ge  null 0 1.568e+7 n *pzz spry
0000526 p      610010000  gt  null 0 1.607e+7 n *porv
0000528 p      610010000  gt  null 0 1.620e+7 n
0000529 time      0 ge  null 0 0.0 1 *pzz prp htrs
0000530 p      610010000  lt  null 0 1.540e+7 n *pzz bkup htrs
0000531 p      610010000  lt  null 0 1.534e+7 n
0000532 cntrlvar 610 lt  null 0 0.25656 n *jo nrm pr lvl
0000535 time      0 ge  null 0 1000.0 1 *tube break
0000536 time      0 ge  null 0 0.0 1 *bl flow
0000537 time      0 lt  null 0 0.0 1 *valve
0000538 time      0 lt  null 0 0.0 1 *il flow
0000539 time      0 lt  null 0 0.0 1 *valve
0000540 time      0 le  null 0 10000.0 n
0000550 p      610010000  ge  null 0 1.297e+7 1 *main feed
0000552 time      0 ge  timeof 505 44.0 1 *aux fed
*0000553 time      0 le  timeof 552 200.0 1 *auxfeed
0000554 cntrlvar 308 lt  null 0 0.44 n *aux feed
0000555 cntrlvar 508 lt  null 0 0.44 n
*0000556 time      0 le  timeof 552 81.0 1 *auxfeed
0000560 p      316010000  gt  null 0 7.82e+6 n *bl sg rel
0000561 p      316010000  gt  null 0 8.2e+6 n
0000564 p      316010000  gt  null 0 7.69e+6 n *bi sg saf
0000565 p      316010000  gt  null 0 8.68e+6 n

```


0000568	time	0	lt	null	0	0.0	n * bl msiv	*
0000569	p	316010000	lt	null	0	4.235e+6	l	*****
0000570	p	516010000	gt	null	0	7.82e+6	n * il sg rel	* reactor vessel
0000571	p	516010000	gt	null	0	8.2e+6	n	*****
0000574	p	516010000	gt	null	0	7.69e+6	n * il sg saf	1000000 inannl snglvol
0000575	p	516010000	gt	null	0	8.68e+6	n	1000101 0.0 1.5684 0.13609 0.0 -90. -1.5684
0000578	time	0	lt	null	0	0.0	n * il msiv	1000102 4.57e-5 0.106 00
0000579	p	516010000	lt	null	0	4.235e+6	l	1000200 003 15479968. 569.1
0000580	cntrivar	308	lt	null	0	0.25	l * low sg lev	*
0000581	cntrivar	508	lt	null	0	0.25	l	*****
0000583	time	0	ge	null	0	0.0	n * strm hdr vlv	1040000 inann branch
0000585	time	0	lt	null	0	0.0	n * strm thrtl	1040001 4 0
0000586	time	0	ge	null	0	11.0	n * valve	1040101 0.0 0.600 0.05425 0.0 -90.0 -0.600 4.57e-5
0000599	time	0	lt	null	0	1000.0	n * ss pres	1040102 0.106 00
*****								1040200 003 15487916. 560.4
* logical trips								1041101 104000000 100010000 0.0 0.0 0.0 0000
*****								1042101 104010000 108000000 0.0 0.0 0.0 0000
0000601	-603	and	571	n	*	il sec relief valve		1043101 252010000 104000000 0.03365 0.345 0.345 0101
0000602	603	and	570	n				1044101 452010000 104000000 0.03365 0.345 0.345 0101
0000603	601	or	602	n				1041201 5.42622-3 5.42622-3 0.0 * 24192712
0000604	-606	and	575	n	*	il sec safety valve		1042201 1.0373539 1.0373539 0.0 * 48.158681
0000605	606	and	574	n				1043201 1.4005447 1.4005447 0.0 * 24.199945
0000606	604	or	605	n				1044201 1.4006109 1.4006109 0.0 * 24.200657
0000607	-609	and	561	n	*	bl sec relief valve		*
0000608	609	and	560	n				*****
0000609	607	or	608	n				1080000 downcmer annulus
0000610	-612	and	565	n	*	bl sec safety valve		1080001 9
0000611	612	and	564	n				1080101 0.09774 9
0000612	610	or	611	n				1080301 0.6757 1
0000613	-615	and	528	n	*	porv		1080302 0.8670 2
0000614	615	and	526	n				1080303 0.610 8
0000615	613	or	614	n				1080304 1.2588 9
0000620	580	or	581	l	*	reactor trip		1080601 -90.0 9
0000621	520	or	620	l				1080701 -0.6757 1
0000622	621	or	501	l				1080702 -0.8670 2
0000623	552	and	554	n	*	sg aux feed, bl		1080703 -0.610 8
0000624	552	and	555	n	*	, il		1080704 -1.2588 9
0000625	-586	or	-586	n	*	steam sir* essure		1080801 4.573e-5 0.106 9
0000626	579	or	568	l	*	hpi		1081001 00 9
0000627	626	or	505	l				1081101 0000 8
0000630	-632	and	531	n	*	p2r backup heater cntl		1081201 003 15482417. 560.5 0.0 0.0 1
0000631	632	and	530	n				1081202 003 15498051. 560.5 0.0 0.0 2
0000632	630	or	631	n				1081203 003 15493443. 560.5 0.0 0.0 3
0000633	-505	and	-532	n	*	p2r htrs off on sis or low p2r lvl		1081204 003 15497895. 560.5 0.0 0.0 4
0000634	632	and	633	n	*	p2r htrs off on low p2r level		1081205 003 15502346. 560.5 0.0 0.0 5
*****								1081206 003 15506796. 560.5 0.0 0.0 6
* hydrodynamic components								1081207 003 15511245. 560.5 0.0 0.0 7
*****								1081208 003 15515694. 560.5 0.0 0.0 8

1081209	003	15522509	560.5	0.	0.	0.	9
1081300	0						
1081301	.96071571	.96071571	0.0	1		* 48.158687	
1081302	.96098280	.96098280	0.0	2		* 48.158693	
1081303	.96122606	.96122606	0.0	3		* 48.158697	
1081304	.96145084	.96145084	0.0	4		* 48.158699	
1081305	.96163484	.96163484	0.0	5		* 48.158700	
1081306	.96176032	.96176032	0.0	6		* 48.158700	
1081307	.96182512	.96182512	0.0	7		* 48.158698	
1081308	.96184417	.96184417	0.0	8		* 48.158695	

1120000	lplovol	snglvol					
1120101	0.0	0.626	0.1661	0.0	90.0	0.626	4.57e-5
1120102	0.0104	00					
1120200	003	15532812	560.5				

1160000	lowrplnm	branch					
1160001	3	0					
1160101	0.0	0.4762	0.0943	0.0	90.0	0.4762	4.57e-5
1160102	0.0104	00					
1160200	003	15538774	560.5				
1161101	108010000	116010000	0.09774	1.0	1.0	0100	
1162101	112010000	116000000	0.23623	0.0	0.0	0000	
1163101	116010000	120000000	0.15931	8.34	8.34	0000	
1161201	.96183851	.96183851	0.0				* 48.158680
1162201	.167004-9	.167679-9	0.0				* 17.0061-9
1163201	.90531130	.90531130	0.0				* 48.158664
1162110	0.0104	1.0	1.0	1.0			
1163110	0.0104	1.0	1.0	1.0			

1200000	corein	branch					
1200001	1	0					
1200101	0.0	1.2588	0.1821	0.0	90.0	1.2588	4.57e-5
1200102	0.0104	00					
1200200	003	15531639	560.5				
1201101	120010000	124000000	0.13657	0.85	0.85	0000	
1201201	.701857	.701857	0.0				* 48.158607
1201110	0.009721	1.0	1.0	1.0			

1240000	core	pipe					
1240001	6						
1240101	0.0	6					
1240201	0.119868	5					
1240301	0.610	6					

1240401	0.07312	6					
1240601	90.0	6					
1240701	0.610	6					
1240801	4.57e-5	0.00832	6				
1240901	0.68	0.68	5				
1241001	00100	6					
1241101	0000	5					
1241201	003	15513996	563.05	0.0	0.0	0.0	1
1241202	003	15518831	567.6	0.0	0.0	0.0	2
1241203	003	15503749	574.15	0.0	0.0	0.0	3
1241204	003	15508764	580.70	0.0	0.0	0.0	4
1241205	003	15493863	584.25	0.0	0.0	0.0	5
1241206	003	15499012	586.5	0.0	0.0	0.0	6
1241300	0						
1241301	1.4034412	1.4034412	0.0	1			* 48.158578
1241302	1.4215501	1.4215501	0.0	2			* 48.158541
1241303	1.4586451	1.4586451	0.0	3			* 48.158496
1241304	1.4601781	1.4601781	0.0	4			* 48.158441
1241305	1.4627423	1.4627423	0.0	5			* 48.158378
1241401	0.00832	1.0	1.0	1.0	5		

1280000	creout	branch					
1280001	3	0					
1280101	0.0	0.867	0.1522	0.0	90.0	0.867	4.57e-5
1280102	0.0	00					
1280200	003	15480901	586.5				
1281101	124010000	128000000	0.15255	1.272	1.272	0000	
1282101	128010000	132000000	0.16737	0.0	0.0	0000	
1283101	156010000	128010000	0.085679	420.	420.	0000	
1281201	3.3840926	3.3840926	0.0				* 48.158308
1282201	.67385815	.67385815	0.0				* 48.399826
1283201	4.39830-3	4.39830-3	0.0				* 24167236
1281110	0.28097	1.0	1.0	1.0			
1282110	0.4063	1.0	1.0	1.0			
1283110	0.3078	1.0	1.0	1.0			

1320000	upplnm	snglvol					
1320101	0.0	0.6757	0.1060	0.0	90.0	0.6757	4.57e-5
1320102	0.321	00					
1320200	003	15485850	586.5				

1360000	upplnm1	branch					
1360001	5	0					
1360101	0.0	0.600	0.09389	0.0	90.0	0.600	4.57e-5
1360102	0.321	00					

```

1360200 003 15481715 586.5
1361101 136000000 200000000 0.05520 0.265 0.265 0102 1560000 gdetub pipe
1362101 136000000 400000000 0.05520 0.265 0.265 0102 1560001 2
1363101 132010000 130000000 0.15669 0.0 0.0 0000 1560101 0.0 2
1364101 140000000 136010000 0.14305 0.0 0.0 0000 1560201 0.0102 1
1365101 104000000 136000000 1.0e-4 40. 40. 0103 1560301 1.9260 1
1361201 95933557 95933557 0.0 * 24.200218 1560302 1.6431 2
1362201 95930429 95930429 0.0 * 24.199069 1560401 0.06209 1
1363201 67669046 67669046 0.0 * 48.399714 1560402 0.06286 2
1364201 -5.8944-6 -5.8944-6 0.0 * -326.21-6 1560601 -90.0 2
1365201 0.802075 0.802175 0.0 * 0.041000 1560701 -1.9260 1
1363110 0.321 1.0 1.0 1.0 1560702 -1.6431 2
1364110 0.321 1.0 1.0 1.0 1560801 4.57e-5 0.0 2
* 1560901 3.34 3.34 1
***** 1561001 00 2
1400000 uptopvol snglvol 1561101 0000 1
1400101 0.0 0.3674 0.0445 0.0 90.0 0.3674 4.57e-5 1561201 003 15469815. 578. 0. 0. 0. 1
1400102 0.321 00 1561202 003 15472498. 584. 0. 0. 0. 2
1400200 003 15488458. 577.5 1561300 0
* 1561301 .04675404 .04675404 0.0 1 * 24169252
*****
* loop with pressurizer (broken loop)
*****
*
2000000 nphotleg snglvol
2000101 0.0337 1.3246 0.0 0.0 0.0 0.0 4.57e-5 0.207 00
2000200 003 15471308. 586.5
*
*****
2020000 bihlbyps branch
2020001 1 0
2020101 3.53e-4 2.65 0.0 0.0 0.0 0.0 4.57e-5 0.0 00
2020200 003 15481269. 560.5
2021101 104010000 202000000 3.53e-4 0.0 0.0 0100
2021201 0.0 0.0 0.0
*
*****
2030000 bihlbyp valve
2030101 202010000 204000000 3.53e-4 27.6 27.6 0100
2030201 0 0.913 0.913 0.0
2030300 srvviv
2030301 203
*
*****
2040000 bihlbyps branch
2040001 1 0
2040101 3.53e-4 1.66 0.0 0.0 90.0 0.30 4.57e-5 0.0 00
2040200 003 15471269. 558.5

```

2041101	204010000	200000000	3.53e-4	0.0	0.0	0101			
2041201	0.0	0.0	0.0						

2060000	wphotleg	branch							
2060001	3	0							
2060101	0.0337	1.3195	0.0	0.0	0.0	0.0	4.57e-5	0.207	00
2060200	003	15471270	586.5						
2062101	200010000	206000000	0.0337	0.0	0.0	0000			
2063101	206010000	208000000	0.0337	0.0	0.0	0000			
2064101	600010000	206010000	0.00352	1.0	0.5	0001			
2062201	1.5682911	1.5682911	0.0				* 24.199021		
2063201	1.5683730	1.5683730	0.0				* 24.200785		
2064201	1154.53-6	1154.53-6	0.0				* 1.80819-3		

2080000	wphotleg	pipe							
2080001	2								
2080101	0.0337	2							
2080301	0.7043	1							
2080302	0.5278	2							
2080601	0.0	1							
2080602	50.0	2							
2080701	0.0	1							
2080702	0.4043	2							
2080801	4.57e-5	0.207	2						
2080901	0.05	0.05	1						
2081001	00	2							
2081101	100000	1							
2081201	003	15471238	586.5	0.0	0.0	0.1			
2081202	003	15479897	586.5	0.0	0.0	0.2			
2081300	0								
2081301	1.5683412	1.5683412	0.0	1			* 24.200096		
2081401	0.0	0.0	0.55	0.785	1				

2090000	nphotleg	sngljun							
2090101	208010000	212000000	0.0337	0.0	0.0	0100			
2090201	0	1.5683441	1.5683441	0.0			* 24.200078		

2120000	npsgin	snglvol							
2120101	0.0	0.706	0.125	0.0	90.0	0.706	4.57e-5		
2120102	0.377	00							
2120200	003	15466381	586.5						

2130000	npsgfbj	sngljun							

2130101	212010000	216000000	0.2093	0.0	0.0	0000			
2130201	0	25232836	25232836	0.0			* 24.199962		

2160000	npsgfb	snglvol							
2160101	0.0	1.1035	0.2323	0.0	90.0	1.1035	4.57e-5		
2160102	0.4474	00							
2160200	003	15460476	586.5						

2170000	npsgin	sngljun							
2170101	216010000	220000000	0.0425	0.0	0.0	100100			
2170110	0.0	0.0	0.725	1.					
2170201	0	1.2407596	1.2407596	0.0			* 24.199843		

2200000	npsgtube	pipe							
2200001	8								
2200101	0.0425	8							
2200301	2.8724	1							
2200302	2.5654	3							
2200303	2.1728	5							
2200304	2.5654	7							
2200305	2.8724	8							
2200601	90.0	4							
2200604	-90.0	8							
2200701	2.8724	1							
2200702	2.5654	3							
2200703	2.0980	4							
2200704	-2.0980	5							
2200705	-2.5654	7							
2200706	-2.8724	8							
2200801	1.524-6	0.0196	8						
2200901	0.0	0.0	3						
2200902	0.006	0.0	4						
2200903	0.006	0.006	5						
2200904	0.0	0.006	6						
2200905	0.0	0.0	7						
2201001	00	8							
2201101	0000	7							
2201201	003	15446205	578.83	0.0	0.0	0.1			
2201202	003	15426456	572.17	0.0	0.0	0.2			
2201203	003	15407430	568.50	0.0	0.0	0.3			
2201204	003	15389925	566.83	0.0	0.0	0.4			
2201205	003	15389288	564.17	0.0	0.0	0.5			
2201206	003	15406534	562.50	0.0	0.0	0.6			
2201207	003	15423494	561.83	0.0	0.0	0.7			
2201208	003	15442582	560.17	0.0	0.0	0.8			

-A.6-

```

2361302 2.1243895 2.1243895 0.0 2 * 24.199912 *
2361303 2.1244048 2.1244048 0.0 3 * 24.199916 *
*
*****
2400000 nprcpump pump
2400101 0.0 0.802 0.0235 0.0 90.0 0.351 0
2400108 236010000 0.0222 0.0 0.0 0000
2400109 244000000 0.0337 0.0525 0.0525 0000
2400200 003 15473807. 560.5
2400201 0 2.1244201 2.1244201 0.0 * 24.199921
2400202 0 1.3993350 1.3993350 0.0 * 24.199925
2400301 0 0 0 -1 0 0 0
2400302 188.50000 .680636 .05400000 10.000000 55.200000
2400303 0.54 750.0 0.0 0.0 0.0 0.0 0.0
*
*****
* single phase head and torque data from lstf sys. description
*****
*
2401100 1 1 0.00 1.36 0.10 1.38 0.24 1.42 0.40 1.41
2401101 0.60 1.32 0.80 1.19 1.00 1.00
2401200 1 2 0.00 -0.97 0.20 -0.68 0.50 -0.20 0.65 0.07
2401201 0.80 0.40 1.00 1.00
2401300 1 3 -1.0 3.20 -0.90 2.80 -0.80 2.46 -0.60 1.94
2401301 -0.40 1.57 -0.20 1.41 0.00 1.36
2401400 1 4 -1.00 3.20 -0.80 2.76 -0.60 2.41 -0.40 2.09
2401401 -0.20 1.81 0.00 1.58
2401500 1 5 0.00 0.00 1.00 0.00
2401600 1 6 0.00 0.00 1.00 0.00
2401700 1 7 -1.00 0.00 0.00 0.00
2401800 1 8 -1.00 0.00 0.00 0.00
*
* torque data
*
2401900 2 1 0.00 0.36 0.12 0.38 0.20 0.44 0.30 0.58
2401901 0.50 0.73 0.70 0.81 1.00 1.00
2402000 2 2 0.00 -1.26 0.10 -0.88 0.30 -0.31 0.50 0.09
2402001 0.65 0.30 0.86 0.63 1.00 1.00
2402100 2 3 -1.00 2.40 -0.85 1.70 -0.65 1.12 -0.50 0.84
2402101 -0.40 0.69 -0.20 0.59 0.00 0.36
2402200 2 4 -1.00 2.40 -0.80 2.12 -0.60 1.80 -0.30 1.32
2402201 0.00 0.80
2402300 2 5 0.00 0.00 1.00 0.00
2402400 2 6 0.00 0.00 1.00 0.00
2402500 2 7 -1.00 0.00 0.00 0.00
2402600 2 8 -1.00 0.00 0.00 0.00
*
* two phase multiplier tables for head of rc pump 240
*
2403000 0 0.0 0.0
2403001 0.10 0.0
2403002 0.15 0.05
2403003 0.24 0.80
2403004 0.30 0.96
2403005 0.40 0.98
2403006 0.60 0.97
2403007 0.80 0.96
2403008 0.90 0.80
2403009 0.96 0.50
2403010 1.00 0.0
*
* two phase multiplier tables for torque of rc pump 240
*
2403100 0 0.0 0.0
2403101 1.0 0.0
*
* two-phase diff curves from r5 built-in data
* head difference curves
*
2404000 1 1 0.00 0.00 0.10 0.83 0.20 1.09 0.50 1.02
2404101 0.70 1.01 0.90 0.94 1.00 1.00
2404200 1 2 0.00 0.00 0.10 -0.40 0.20 0.00 0.30 0.10
2404201 0.40 0.21 0.80 0.67 0.90 0.80 1.00 1.00
2404300 1 3 -1.00 -1.16 -0.90 -1.24 -0.80 -1.77 -0.70 -2.36
2404301 -0.60 -2.79 -0.50 -2.91 -0.40 -2.67 -0.25 -1.69
2404302 -0.10 -0.50 0.00 0.00
2404400 1 4 -1.00 -1.16 -0.90 -0.78 -0.80 -0.50 -0.70 -0.31
2404401 -0.60 -0.17 -0.50 -0.08 -0.35 0.00 -0.20 0.05
2404402 -0.10 0.08 0.00 0.11
2404500 1 5 0.00 0.00 1.00 0.00
2404600 1 6 0.00 0.00 1.00 0.00
2404700 1 7 -1.00 0.00 0.00 0.00
2404800 1 8 -1.00 0.00 0.00 0.00
*
* torque difference curves
*
2404900 2 1 0.0 0.0 0.0 0.0
2405000 2 2 0.0 0.0 0.0 0.0
2405100 2 3 0.0 0.0 0.0 0.0
2405200 2 4 0.0 0.0 0.0 0.0
2405300 2 5 0.0 0.0 0.0 0.0
2405400 2 6 0.0 0.0 0.0 0.0
2405500 2 7 0.0 0.0 0.0 0.0
2405600 2 8 0.0 0.0 0.0 0.0
*
* pump coastdown data

```



```

*
2406100 501 * norm speed
2406101 0.0 128.3 * 160.22
2406102 80.0 128.3 * 160.22
2406103 83.0 122.0 * 153.75
2406104 86.0 118.9 * 149.87
2406105 89.0 114.9 * 144.86
2406106 101.0 96.7 * 121.90
2406107 110.0 82.6 * 104.12
2406108 119.0 74.4 * 93.77
2406109 131.0 63.4 * 79.86
2406110 140.0 56.7 * 71.46
2406111 149.0 51.8 * 65.31
2406112 161.0 46.3 * 58.36
2406113 170.0 41.7 * 52.54
2406114 179.0 38.2 * 48.18
2406115 191.0 34.8 * 43.81
2406116 200.0 32.3 * 40.74
2406117 209.0 30.0 * 37.38
2406118 221.0 27.3 * 34.43
2406119 230.0 25.3 * 31.85
2406120 239.0 23.2 * 29.26
2406121 251.0 21.4 * 27.00
2406122 260.0 20.3 * 25.54
2406123 269.0 19.0 * 23.92
2406124 281.0 16.3 * 20.53
2406125 290.0 14.6 * 18.43
2406126 299.0 12.4 * 15.60
2406127 320.0 9.9 * 12.48
2406128 341.0 7.4 * 9.36
2406129 359.0 5.0 * 6.24
2406130 380.0 2.5 * 3.12
2406131 400.0 0.0
2406132 1000.0 0.0
*
*****
2440000 wpcolleg snglvol
2440101 0.0337 1.0562 0.0 0.0 0.0 0.0 4.57e-5 0.207 00
2440200 003 15487643. 560.5
*
*****
2480000 wpcolleg branch
2480001 3 0
2480101 0.0337 1.1945 0.0 0.0 0.0 0.0 4.57e-5 0.207 00
2480200 003 15487614. 560.5
2481101 244010000 248000000 0.0337 0.0 0.0 0000
2482101 248010000 252000000 0.0337 0.0 0.0 0000
2483101 790010000 248010000 0.0060 1.0 0.5 0001
2481201 1.3993524 1.3993524 0.0 * 24.200649
2482201 1.3993528 1.3993528 0.0 * 24.200653
2483201 .574788-9 .574777-9 0.0 * 2.38120-9
*
*****
2520000 wpcolleg snglvol
2520101 0.0337 1.3125 0.0 0.0 0.0 0.0 4.57e-7 0.207 00
2520200 003 15487585. 560.5
*
*****
* secondary loop for the broken loop
*
*****
3000000 npstgdcn annulus
3000001 5
3000101 0.0 1
3000102 0.0296 4
3000103 0.0 5
3000201 0.0 3
3000202 0.005281 4
3000301 2.8965 1
3000302 2.0980 2
3000303 2.5654 4
3000304 3.4395 5
3000401 0.3228 1
3000402 0.0 4
3000403 0.1302 5
3000501 0.0 5
3000601 -90.0 5
3000701 -2.0223 1
3000702 -2.0980 2
3000703 -2.5654 4
3000704 -2.5464 5
3000801 4.57e-5 0.3689 1
3000802 4.57e-5 0.0971 4
3000803 4.57e-5 0.0801 5
3000901 0.0 0.0 4
3001001 00 5
3001101 0000 3
3001102 0100 4
3001201 003 6850719. 546 0.0 0.0 1
3001202 003 6865934. 546 0.0 0.0 2
3001203 003 6883272. 546 0.0 0.0 3
3001204 003 6912349. 546 0.0 0.0 4
3001205 003 69371666. 546 0.0 0.0 5
3001300 0
3001301 .61390359 .61390359 0.0 1 * 13.834317

```

3001302	.61389325	.61389325	0.0	2	* 13.834278	*
3001303	.61387866	.61387866	0.0	3	* 13.834214	*****
3001304	.61386007	.61386007	0.0	4	* 13.834133	3080000 npsepar separatr
*						3080001 3 0
*****						3080101 0.0 2.120 0.572 0.0 90.0 2.120 4.57e-5
3010000	npstgdcn	sngljun				3080102 0.2134 00
3010101	300010000	304000000	0.0 100.0 100.0 0000			3080200 0 6844560.2 1263471.6 2580768.1 50638217
3010201	0	.48038520 .69708130 0.0		* 13.833941		3081101 308010000 316000000 0.0615 0.0 0.0 0100 0.2
*						3082101 308000000 300000000 0.03964 100.0 100.0 0000
*****						3083101 304010000 308000000 0.1986 0.0 0.0 0000
3040000	blsteamg	pipe				3081201 -.3840036 .27406855 0.0 * 2.7469745
3040001	5					3082201 .37743398 -1.777076 0.0 * 11.041964
3040101	0.2293	3				3083201 .11701332 1.0458935 0.0 * 13.801835
3040102	0.0	5				*
3040201	0.2293	2				*****
3040202	0.2323	3				3120000 npsgspbp branch
3040203	0.3138	4				3120001 2 0
3040301	2.5464	1				3120101 0.0 2.120 0.6288 0.0 90.0 2.120 4.57e-5
3040302	2.5654	3				3120102 0.1242 00
3040303	2.0980	4				3120200 0 6841893.0 1236857.5 2584233.4 .87891994
3040304	2.0223	5				3121101 300000000 312000000 0.3164 0.0 0.0 0000
3040401	0.0	3				3122101 312010000 316000000 0.0392 1.5 1.5 0000
3040402	0.4951	4				3121201 30.0480-6 1.1555824 0.0 * 7.23798-3
3040403	0.7979	5				3122201 -42.50990 -1.5229-3 0.0 * -2.6126-3
3040501	0.0	5				*
3040601	90.0	5				*****
3040701	2.5464	1				3160000 stndome snglvol
3040702	2.5654	3				3160101 0.0 3.7778 2.0288 0.0 90.0 3.7778 4.57e-5
3040703	2.0980	4				3160102 0.7696 00
3040704	2.0223	5				3160200 0 6849946.7 1262926.9 2580859.5 .99999968
3040801	4.57e-5	0.036 4				*
3040802	4.57e-5	0.219 5				*****
3040901	1.435 1.435 4					* blsg steam line
3041001	00 5					*****
3041101	0000 3					3200000 blstm1n1 branch
3041102	0000 4					3200001 2 0
3041201	0 6900485.9 1261112.3 2580244.6 .14219192 0.0 1					3200101 0.0286 5.286 0.0 0.0 0.0 0.0 4.57e-5
3041202	0 6887036.6 1264931.2 2580399.8 .28828728 0.0 2					3200102 0.1909 00
3041203	0 6874704.9 1264683.5 2580530.3 .28643954 0.0 3					3200200 0 6849057.2 1262882.9 2580880.3 .99999786
3041204	0 6863302.6 1264128.3 2580649.9 .27887377 0.0 4					3201101 316010000 320000000 0.0286 0.0 0.0 0100
3041205	0 6853423.5 1263801.8 2580702.3 .27518532 0.0 5					3202101 320010000 324000000 0.0286 0.0 0.0 0000
3041300	0					3201201 2.4791454 2.5876488 0.0 * 2.7470311
3041301	.09940788 .37087476 0.0 1			* 13.810074		3202201 2.4234202 2.5881767 0.0 * 2.7472440
3041302	.11458638 .49504010 0.0 2			* 13.804585		*
3041303	.10794204 .71300003 0.0 3			* 13.806420		*****
3041304	.09899163 .87128853 0.0 4			* 13.799040		3240000 blstm1n2 branch
3041401	0.036 1.0 1.0 1.0 3					3240001 1 0
3041402	0.1258 1.0 1.0 1.0 4					3240101 0.0286 9.9213 0.0 0.0 0.0 0.0 4.57e-5

```

3240102 0.1909 00
3240200 0 6848966.1 1262878.4 2580896.2 99999675
3241101 324010000 328000000 0.00429 0.0 0.0 0000
3241201 14.028836 17.257852 0.0 * 2.7477108
*
*****
3280000 blsm3n3 snglvol
3280101 0.00429 8.3215 0.0 0.0 0.0 0.0 4.57e-5
3280102 0.0739 00
3280200 0 6828063.0 1262339.0 2580962.3 99998690
*
*****
3290000 blmsiv valve
3290101 328010000 332000000 0.00429 0.0 0.0 0100
3290201 0 12.637699 17.284590 0.0 * 2.7477202
3290300 mtrvrv
3290301 568 501 2.0000000 1.0000000 0
*
*****
3320000 vlvtoiv snglvol
3320101 0.00429 6.446 0.0 0.0 0.0 0.0 4.57e-5
3320102 0.0739 00
3320200 0 6828346.0 1261857.2 2581064.5 99997696
*
*****
3330000 blchkvl valve
3330101 332010000 804000000 0.00429 0.0 0.0 0000
3330201 0 10.389571 17.310434 0.0 * 2.7477882
3330300 chkvlv
3330310 0 0 0.0 0.0
*
*****
3500000 auxfed tmdpvvl
3500101 8.0 5.0 0.0 0.0 0.0 0.0 0 00
3500200 3
3500201 0.0 5.95300e+6 313.0
*
*****
3510000 auxfed tmdpjvn
3510101 350000000 300000000 0.004
3510200 1 623
3510201 0.0 0.0 0.0 0.0
3510202 0.01 1.500 0.0 0.0
3510203 5000.0 1.500 0.0 0.0
*
*****
3600000 npstegfw tmdpvvl
3600101 0.139 5.0 0.0 0.0 0.0 0.0 0 00
3600200 3

```

```

3600201 0.0 5.83400e+6 -195.35
*
*****
3610000 npstegfw tmdpjvn
3610101 360000000 300000000 4.00e-3
3610200 1 550 cntrivar 361
3610201 0.0 0.0 0.0 0.0
3610202 5.0 5.0 0.0 0.0
3610203 7.0 7.0 0.0 0.0
3610204 1000.0 7.0 0.0 0.0
*
*****
* secondary relief and safety valves, broken loop
*****
*
3690000 blsgrv valve
3690101 320010000 370000000 2.96e-4 0.0149 0.0 0100
3690201 0 0.0 0.0 0.0 * 0.0
3690300 trpvrv
3690301 609
*
*****
3700000 contain tmdpvvl
3700101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 00
3700200 3
3700201 0.0 1.01325e+5 293.15
*
*****
3790000 blsgsv valve
3790101 324010000 380000000 0.00195 0.00055 0.0 0100
3790201 0 0.0 0.0 0.0 * 0.0
3790300 trpvrv
3790301 612
*
*****
3800000 contain tmdpvvl
3800101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 00
3800200 3
3800201 0.0 1.01325e+5 293.15
*
*****
* loop without pressurizer (intact loop)
*****
*
4000000 wphotdeg snglvol
4000101 0.0337 1.3246 0.0 0.0 0.0 0.0 4.57e-5 0.207 00
4000200 003 15471308 586.5
*

```

```

*****
4020000    ihlbyps    branch
4020001    1          0
4020101    3.53e-4  2.65  0.0 0.0 0.0 0.0 4.57e-5 0.0 00
4020200    003      15481269  560.5
4021101    104010000 402000000 3.53e-4 0.0 0.0 0100
4021201    0.0 0.0 0.0
*
*****
4030000    blhlbyp    valve
4030101    402010000 404000000 3.53e-4 27.6 27.6 0100
4030201    0      0.913 0.913 0.0
4030300    srvviv
4030301    403
*
*****
4040000    blhlbyps    branch
4040001    1          0
4040101    3.53e-4  1.66  0.0 0.0 90.0 0.30 4.57e-5 0.0 00
4040200    003      15471269  558.5
4041101    404010000 400000000 3.53e-4 0.0 0.0 0101
4041201    0.0 0.0 0.0
*
*****
4060000    nphotleg    branch
4060001    2          0
4060101    0.0337 1.3843 0.0 0.0 0.0 0.0 4.57e-5 0.207 00
4060200    003      15471269  586.5
4061101    400010000 406000000 0.0337 0.0 0.0 0000
4062101    406010000 408000000 0.0337 0.0 0.0 0000
4061201    1.5683423 1.5683423 0.0 * 24.200171
4062201    1.5683417 1.5683417 0.0 * 24.200126
*
*****
4080000    wphotleg    pipe
4080001    2
4080101    0.0337      2
4080301    0.7043      1
4080302    0.5278      2
4080601    0.0         1
4080602    50.0        2
4080701    0.0         1
4080702    0.4043      2
4080801    4.57e-5 0.207 2
4080901    0.05 0.05 1
4081001    00         2
4081101    100000      1
4081201    003      15471238  586.5 0.0 0.0 0.0 1
4081202    003      15479897  586.5 0.0 0.0 0.0 2
4081300    0
4081301    1.5683725 1.5683725 0.0 1 * 24.200756
4081401    0.0 0.0 0.55 0.785 1
*
*****
4090000    wphotleg    sngljun
4090101    408010000 412000000 0.0337 0.0 0.0 0100
4090201    0      1.5683754 1.5683754 0.0 * 24.200738
*
*****
4120000    wpsgin      snglvol
4120101    0.0 0.706 0.125 0.0 90.0 0.706 4.57e-5
4120102    0.377 00
4120200    003      15466381  586.5
*
*****
4160000    wpsgfb      branch
4160001    3          0
4160101    0 1.1035 0.2323 0.0 90.0 1.1035 4.57e-5
4160102    0.4474 00
4160200    003      15460476  586.5
4162101    412010000 416000000 0.2093 0.0 0.0 0000
4163101    416010000 420000000 0.04254 0.0 0.0 0000
4164101    416010000 417000000 5.0e-4 0.0 0.0 0100
4162201    1.247 1.247 0.0
4163201    1.247 1.247 0.0
4164201    0.1 0.1 0.0
*
*****
4170000    bktln1      snglvol
4170101    5.0e-4 1.18 0.0 0.0 0.0 0.0 4.57e-5 0.0 00
4170200    003      15453426  560.5
*
*****
4180000    bktln4      branch
4180001    2          0
4180101    5.0e-4 2.06 0.0 0.0 -90.0 -2.06 4.57e-5 0.0 00
4180200    003      15441269  586.5
4181101    417010000 418000000 5.0e-4 0.0 0.0 0000
4182101    418010000 419000000 5.0e-4 0.0 0.0 0000
4181201    0.1 0.1 0.0
4182201    0.1 0.1 0.0
*
*****
4190000    bktln5      snglvol
4190101    5.0e-4 1.9 0.0 0.0 0.0 0.0 4.57e-5 0.0 00
4190200    003      15433426  560.5

```

```

*
4930000 break valve
4930101 419010000 494000000 5.0e-4 0.0 0.0 0000
4930201 1 0.0 0.0 0.0
4930300 trpvlv
4930301 535

```

```

*
4940000 bkln5 snglvol
4940101 5.0e-4 0.24 0.0 0.0 0.0 0.0 4.57e-5 0.0 00
4940200 003 7310426 540.5

```

```

*
4950000 bkln4 branch
4950001 2 0
4950101 5.0e-4 0.35 0.0 0.0 90.0 0.35 4.57e-6 0.0 00
4950200 003 7311269 546.5
4951101 495010000 496000000 3.02e-5 0.0 0.0 0100
4952101 494010000 495000000 5.0e-4 0.0 0.0 0000
4951201 0.1 0.1 0.0
4952201 0.1 0.1 0.0

```

```

*
4960000 brknoz1 pipe
4960001 3
4960101 3.02e-5 3
4960301 0.6 3
4960401 0.0 3
4960601 90.0 3
4960701 0.6 3
4960801 1.2e-7 0.0062 3
4960901 0.0 0.0 2
4961001 00 3
4961101 01000 2
4961201 003 7315536 546.50 0.0 0.0 1
4961202 003 7325536 546.50 0.0 0.0 2
4961203 003 7330536 546.50 0.0 0.0 3
4961300 0
4961301 0.1 0.1 0.0 1
4961302 0.1 0.1 0.0 2

```

```

*
4970000 bkln2 branch
4970001 2 0
4970101 5.0e-4 0.75 0.0 0.0 90.0 0.75 4.57e-6 0.0 00
4970200 003 7331269 546.5
4971101 496010000 497000000 3.02e-5 0.0 0.0 0100
4972101 497010000 498000000 5.0e-4 0.0 0.0 0000
4971201 0.1 0.1 0.0
4972201 0.1 0.1 0.0

```

```

*
4980000 bkln2 pipe
4980001 2
4980101 5.0e-4 2
4980301 1.25 2
4980601 0.0 2
4980701 0.0 2
4980801 4.57e-5 0.0 2
4980901 0.0 0.0 1
4981001 00 2
4981101 0000 1
4981201 003 7344729 540.5 0.0 0.0 1
4981202 003 7350523 540.5 0.0 0.0 2
4981300 0
4981301 0.1 0.1 0.0 1

```

```

*
4990000 bkln1 sngljun
4990101 498010000 504010003 5.0e-4 0.0 0.0 0100
4990201 0 0.1 0.1 0.0

```

```

*****
4200000 wpsgtube pipe
4200001 5
4200101 0.04254 5
4200301 2.8724 1
4200302 2.5654 3
4200303 2.1728 5
4200601 90.0 4
4200602 -90.0 5
4200701 2.8724 1
4200702 2.5654 3
4200703 2.0980 4
4200704 -2.0980 5
4200801 1.524-6 0.0196 5
4200901 0.0 0.0 3
4200902 0.006 0.0 4
4201001 00 5
4201101 0000 4
4201201 003 15446206 578.83 0.0 0.0 1
4201202 003 15426457 572.17 0.0 0.0 2
4201203 003 15407432 568.5 0.0 0.0 3
4201204 003 15389928 566.83 0.0 0.0 4
4201205 003 15389291 564.17 0.0 0.0 5
4201300 0

```

```

4201301 1.1884545 1.1884545 0.0 1 * 24.200508
4201302 1.1561451 1.1561451 0.0 2 * 24.200513
4201303 1.1379927 1.1379927 0.0 3 * 24.200523
4201304 1.1274428 1.1274428 0.0 4 * 24.200534

```

```

*
*****
4220000 wpsgtub2 pipe
4220001 3
4220101 0.04254 3
4220301 2.5654 2
4220302 2.8724 3
4220601 -90.0 3
4220701 -2.5654 2
4220702 -2.8724 3
4220801 1.524-6 0.0196 3
4220901 0.0 0.006 1
4220902 0.0 0.0 2
4221001 00 3
4221101 0000 2
4221201 003 15405536. 562.50 0. 0. 0. 1
4221202 003 15423494. 561.83 0. 0. 0. 2
4221203 003 15442580. 560.17 0. 0. 0. 3
4221300 0
4221301 1.1140999 1.1140999 0.0 1 * 24.200557
4221302 1.1119639 1.1119639 0.0 2 * 24.200568
*
*****
4230000 bsgtjun sngljun
4230101 420010000 422000000 0.04254 0.4 0.4 00100
4230201 0 1.1200999 1.1200999 0.0
*
*****
4240000 wpsgfbo branch
4240001 2 0
4240101 0 1.1035 0.2323 0.0 -90.0 -1.1035 4.57e-5
4240102 0.4474 00
4240200 003 15456790. 560.5
4242101 422010000 424000000 0.04254 0.0 0.0 0000
4243101 424010000 430000000 0.2093 0.0 0.0 0000
4242201 1.247 1.247 0.0
4243201 1.247 1.247 0.0
*
*****
4300000 wpsgout snglvol
4300101 0.0 0.706 0.125 0.0 -90.0 -0.706 4.57e-5
4300102 0.377 00
4300200 003 15463426. 560.5
*
*****
4290000 wpcrsleg sngljun
4290101 430010000 432000000 0.0222 0.0 0.0 0100
4290201 0 2.1246026 2.1246026 0.0 * 24.200614
*
*****
4320000 wpcrsleg pipe
4320001 5
4320101 0.0222 5
4320301 0.516 1
4320302 1.2422 4
4320303 1.1919 5
4320601 -50.0 1
4320602 -90.0 4
4320603 0.0 5
4320701 -0.3953 1
4320702 -1.2422 4
4320703 0.0 5
4320801 4.57e-5 0.1682 5
4320901 0.036 0.036 1
4320902 0.0 0.0 3
4320903 0.065 0.065 4
4321001 00 5
4321101 0000 4
4321201 003 15466368. 560.5 0. 0. 0. 1
4321202 003 15462310. 560.5 0. 0. 0. 2
4321203 003 15471332. 560.5 0. 0. 0. 3
4321204 003 15480354. 560.5 0. 0. 0. 4
4321205 003 15494820. 560.5 0. 0. 0. 5
4321300 0
4321301 2.1245970 2.1245970 0.0 1 * 24.200615
4321302 2.1245858 2.1245858 0.0 2 * 24.200619
4321303 2.1245689 2.1245689 0.0 3 * 24.200622
4321304 2.1245520 2.1245520 0.0 4 * 24.200625
*
*****
4330000 wpciv valve
4330101 432010000 436000000 0.0222 0.0 0.0 0100
4330201 0 2.1245435 2.1245435 0.0 * 24.200629
4330300 mtrviv
4330301 538 539 1.4200000 1.0000000 0
*
*****
4360000 wpcrsleg pipe
4360001 4
4360101 0.0222 4
4360301 1.1919 1
4360302 1.1222 2
4360303 1.1763 3
4360304 1.1222 4
4360601 0.0 1
4360602 90.0 4

```


4360701	0.0	1							
4360702	1.1222	4							
4360801	4.57e-5	0.1682	4						
4360901	0.065	0.065	1						
4360902	0.0	0.0	3						
4361001	00	4							
4361101	0000	3							
4361201	003	15494729	560.5	0.0	0.0	0.0	1		
4361202	003	15480523	560.5	0.0	0.0	0.0	2		
4361203	003	15472201	560.5	0.0	0.0	0.0	3		
4361204	003	15463879	560.5	0.0	0.0	0.0	4		
4361300	0								
4361301	2.1245435	2.1245435	0.0				1		* 24.200632
4361302	2.1245512	2.1245512	0.0				2		* 24.200635
4361303	2.1245664	2.1245664	0.0				3		* 24.200638

4400000	wprcpump	pump							
4400101	0.0	0.802	0.0235	0.0	90.0	0.351	00		
4400108	436010000	0.0222	0.0	0.0	0000				
4400109	444000000	0.0337	0.0525	0.0525	0000				
4400200	003	15473801	560.5						
4400201	0	2.1245817	2.1245817	0.0					* 24.200642
4400202	0	1.3993995	1.3993995	0.0					* 24.200645
4400301	240	240	240	-1	0	0	0		
4400302	188.50000	65942	.05400000	10.000000	55.200000				
4400303	0.54	750.0	0.0	0.0	0.0	0.0	0.0		

*
* pump coastdown data
*

4406100	501		* norm speed						
4406101	0.0	124.3	* 160.22						
4406102	80.0	124.3	* 160.22						
4406103	83.0	118.2	* 153.75						
4406104	86.0	115.2	* 149.87						
4406105	89.0	111.4	* 144.86						
4406106	101.0	93.7	* 121.90						
4406107	110.0	80.1	* 104.12						
4406108	119.0	72.1	* 93.77						
4406109	131.0	61.4	* 79.86						
4406110	140.0	54.9	* 71.46						
4406111	149.0	50.2	* 65.31						
4406112	161.0	44.9	* 58.36						
4406113	170.0	40.4	* 52.54						
4406114	179.0	37.0	* 48.18						
4406115	191.0	33.7	* 43.81						
4406116	200.0	31.3	* 40.74						
4406117	209.0	29.1	* 37.38						

4406118	221.0	26.5	* 34.43						
4406119	230.0	24.5	* 31.85						
4406120	239.0	22.5	* 29.26						
4406121	251.0	20.8	* 27.00						
4406122	260.0	19.6	* 25.54						
4406123	269.0	18.4	* 23.92						
4406124	281.0	15.8	* 20.53						
4406125	290.0	14.2	* 18.43						
4406126	299.0	12.0	* 15.60						
4406127	320.0	9.6	* 12.48						
4406128	341.0	7.2	* 9.36						
4406129	359.0	4.8	* 6.24						
4406130	380.0	2.4	* 3.12						
4406131	400.0	0.0							
4406132	1000.0	0.0							

4440000	npcolleg	branch							
4440001	2	0							
4440101	0.0337	0.7348	0.0	0.0	0.0	0.0	4.57e-5	0.207	00
4440200	003	15487656	560.5						
4441101	444010000	448000000	0.0337	0.0	0.0	0000			
4442101	740010000	444010000	0.0060	1.0	0.5	0001			
4441201	1.3992878	1.3992878	0.0						* 24.199929
4442201	204252-9	204251-9	0.0						* .845944-9

4480000	npcolleg	branch							
4480001	1	0							
4480101	0.0337	0.9429	0.0	0.0	0.0	0.0	4.57e-5	0.207	00
4480200	003	15487636	560.5						
4482101	448010000	452000000	0.0337	0.0	0.0	0000			
4482201	1.3992879	1.3992879	0.0						* 24.199934

4520000	npcolleg	pipe							
4520001	2								
4520101	0.0337	2							
4520301	0.9752	2							
4520601	0.0	2							
4520701	0.0	2							
4520801	4.57e-5	0.207	2						
4521001	00	2							
4521101	0000	1							
4521201	003	15487611	560.5	0.0	0.0	0.0	1		
4521202	003	15487584	560.5	0.0	0.0	0.0	2		
4521300	0								
4521301	1.3992883	1.3992883	0.0				1		* 24.199940

```

*
*****
*
* secondary loop for the primary loop with pressurizer
*
*****
5000000 wpstgdcn annulus
5000001 5
5000101 0.0 1
5000102 0.0296 4
5000103 0.0 5
5000201 0.0 3
5000202 0.005281 4
5000301 2.8965 1
5000302 2.0980 2
5000303 2.5654 4
5000304 3.4395 5
5000401 0.3228 1
5000402 0.0 4
5000403 0.1302 5
5000501 0.0 5
5000601 -90.0 5
5000701 -2.0223 1
5000702 -2.0980 2
5000703 -2.5654 4
5000704 -2.5464 5
5000801 4.57e-5 0.3689 1
5000802 4.57e-5 0.0971 4
5000803 4.57e-5 0.0801 5
5000901 0.0 0.0 4
5001001 00 5
5001101 0000 3
5001102 0100 4
5001201 0 6854312.9 1200751.2 2580753.5 0.0 0.0 1
5001202 0 6879527.0 1200829.9 2580590.8 0.0 0.0 2
5001203 0 6886864.0 1200899.7 2580405.7 0.0 0.0 3
5001204 0 6905938.6 1200941.7 2580202.5 0.0 0.0 4
5001205 0 6915253.0 1202649.1 2580103.4 0.0 0.0 5
5001300 0
5001301 .61387739 .61387739 0.0 1 * 13.832253
5001302 .61388537 .61388537 0.0 2 * 13.832171
5001303 .61388694 .61388694 0.0 3 * 13.832038
5001304 .61387788 .61387788 0.0 4 * 13.831877
*
*****

```

```

*****
5010000 wpstgdcn sngljun
5010101 500010000 504000000 0.0 100.0 100.0 0000
5010201 0 48039121 .69720931 0.0 * 13.831555

```

```

*
*****
5040000 wpsteamg pipe
5040001 5
5040101 0.2293 3
5040102 0.0 5
5040201 0.2293 2
5040202 0.2293 3
5040203 0.3138 4
5040301 2.5464 1
5040302 2.5654 3
5040303 2.0980 4
5040304 2.0223 5
5040401 0.0 3
5040402 0.4951 4
5040403 0.7979 5
5040501 0.0 5
5040601 90.0 5
5040701 2.5464 1
5040702 2.5654 3
5040703 2.0980 4
5040704 2.0223 5
5040801 4.57e-5 0.036 4
5040802 4.57e-5 0.219 5
5040901 15 15 4
5041001 00 5
5041101 0100 3
5041102 0000 4
5041201 0 6904072.6 1261303.5 2580206.5 14246717 0.0 1
5041202 0 6890625.7 1265108.6 2580362.4 28828137 0.0 2
5041203 0 6878293.4 1264860.6 2580492.4 28643270 0.0 3
5041204 0 6866890.7 1264305.8 2580611.9 27887426 0.0 4
5041205 0 6857011.3 1263978.6 2580664.8 27519078 0.0 5
5041300 0
5041301 .09947453 .37096577 0.0 1 * 13.814456
5041302 .11462864 .49520300 0.0 2 * 13.809526
5041303 .10797253 .71294955 0.0 3 * 13.805859
5041304 .09902432 .87101253 0.0 4 * 13.802399
5041401 0.036 1.0 1.0 1.0 3
5041402 0.1258 1.0 1.0 1.0 4
*
*****

```

```

*****
5080000 wpsepar separatr
5080001 3 0
5080101 0.0 2.120 0.572 0.0 90.0 2.120 4.57e-5
5080102 0.2134 00
5080200 0 6848284.2 1263648.5 2580734.6 52097025
5081101 508010000 516000000 0.0715 0.0 0.0 0100 0.2

```

```

5082101 508000000 500000000 0.03964 100.0 100.0 0000
5083101 504010000 508000000 0.1986 0.0 0.0 0000
5081201 -4037061 27393586 0.0 * 2.7472266
5082201 37739895 -1.743057 0.0 * 11.039985
5083201 11699245 1.0455258 0.0 * 13.799421
*
*****
5120000 wpsgspbp branch
5120001 2 0
5120101 0.0 2.120 0.6288 0.0 90.0 2.120 4.57e-5
5120102 0.1242 00
5120200 0 6845583.4 1236787.3 2582575.1 .89235283
5121101 500000000 512000000 0.3164 0.0 0.0 0000
5122101 512010000 516000000 0.0392 1.5 1.5 0000
5121201 30.5398-6 1.3297404 0.0 * 7.35566-3
5122201 -46.00500 -1.6715-3 0.0 * -2.8209-3
*
*****
5160000 stmdome snglvol
5160101 0.0 3.7778 2.0288 0.0 90.0 3.7778 4.57e-5
5160102 0.7696 00
5160200 0 6843731.5 1263114.0 2580824.8 .99999971
*
*****
* ilsg steam line
*****
5200000 ilstmin1 branch
5200001 2 0
5200101 0.0286 5.282 0.0 0.0 0.0 0.0 4.57e-5
5200102 0.1909 00
5200200 0 6842807.7 1263069.3 2580824.5 .99991553
5201101 516010000 520000000 0.0286 0.0 0.0 0100
5202101 520010000 524000000 0.0286 0.0 0.0 0000
5201201 1.8244014 2.5842639 0.0 * 2.7450542
5202201 27793749 2.5848676 0.0 * 2.7455870
*
*****
5240000 ilstmin2 branch
5240001 1 0
5240101 0.0286 8.5867 0.0 0.0 0.0 0.0 4.57e-5
5240102 0.1909 00
5240200 0 6842699.9 1263063.4 2580835.0 .99967266
5241101 524010000 528000000 0.00429 0.0 0.0 0000
5241201 1.5658958 17.236995 0.0 * 2.7466368
*
*****
5280000 ilstmin3 snglvol
5280101 0.00429 10.9965 0.0 0.0 0.0 0.0 4.57e-5
5280102 0.0739 00
5280200 0 6820393.8 1262454.1 2580955.8 .99988240
*
*****
5290000 ilmsiv valve
5290101 528010000 532000000 0.00429 0.0 0.0 0100
5290201 0 5.7878014 17.263954 0.0 * 2.7467386
5290300 mtrvrv
5290301 578 501 2.0000000 1.0000000 0
*
*****
5320000 vlvtovlv snglvol
5320101 0.00429 5.5275 0.0 0.0 0.0 0.0 4.57e-5
5320102 0.0739 00
5320200 0 6828376.3 1261858.7 2581063.9 .99978697
*
*****
5330000 ilchkvl valve
5330101 532010000 800000000 0.00429 0.0 0.0 0000
5330201 0 3.7947922 17.296149 0.0 * 2.7468079
5330300 chkvly
5330310 0 0 0.0 0.0
*
*****
5500000 auxfed tmdpvol
5500101 8.0 5.0 0.0 0.0 0.0 0.0 0 00
5500200 3
5500201 0.0 5.95300e+6 313.0
*
*****
5510000 auxfed tmdpjvn
5510101 550000000 500000000 0.004
5510200 1 624
5510201 0.0 0.0 0.0 0.0
5510202 0.01 1.140 0.0 0.0
5510203 5000.0 1.140 0.0 0.0
*
*****
5600000 wpstegfw tmdpvol
5600101 0.139 5.0 0.0 0.0 0.0 0.0 0 00
5600200 3
5600201 0.0 5.83400e+6 495.35
*
*****
5610000 wpstegfw tmdpjvn
5610101 560000000 500000000 4.00e-3
5610200 1 550 cntrlvar 561
5610201 0.0 0.0 0.0 0.0
5610202 5.0 5.0 0.0 0.0

```

5610203	7.0	7.0	0.0	0.0					
5610204	1000.0	7.0	0.0	0.0					

* secondary relief and safety valves, broken loop									

5690000	blsgrv	valve							
5690101	520010000	5700000000	2.96e-4	0.0164	0.0	0.100			
5690201	0	0.0	0.0	0.0				*	0.0
5690300	trpvlv								
5690301	603								

5700000	contain	tmdpvol							
5700101	1.0e+8	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5700200	3								
5700201	0.0	1.01325e+5	293.15						

5790000	blsgsv	valve							
5790101	524010000	5800000000	0.00195	0.00050	0.0	0.100			
5790201	0	0.0	0.0	0.0				*	0.0
5790300	trpvlv								
5790301	606								

5800000	contain	tmdpvol							
5800101	1.0e+8	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5800200	3								
5800201	0.0	1.01325e+5	293.15						

* pressurizer									

6000000	prssurgl	pipe							
6000001	3								
6000101	3.515e-3	3							
6000301	6.7788	1							
6000302	9.245	2							
6000303	5.4221	3							
6000401	0.0	3							
6000601	-90.0	3							
6000701	-4.4077	1							
6000702	-4.995	2							
6000703	-2.5768	3							
6000801	4.57e-5	0.0669	3						

6001001	00	3							
6001101	0000	2							
6001201	0	15410474.1556744.0	2445245.8	0.0	0.0	1			
6001202	0	15449376.1533202.1	2444562.7	0.0	0.0	2			
6001203	0	15463068.1499159.9	2444003.5	0.0	0.0	3			
6001300	0								
6001301	794.073-6	794.073-6	0.0	1				*	1.73199-3
6001302	793.544-6	793.544-6	0.0	2				*	1.76418-3

6030000	prssurgl	snlgjun							
6030101	610010000	6000000000	3.515e-3	0.0	0.0	0.100			
6030201	0	794.821-6	-7.2196-3	0.0				*	1.70555-3

6100000	prsrizer	pipe							
6100001	8								
6100101	0.0	1							
6100102	0.2827	6							
6100103	0.2731	8							
6100201	0.0	7							
6100301	0.201	1							
6100302	0.470	3							
6100303	0.600	4							
6100304	0.682	6							
6100305	0.5375	8							
6100401	0.0325	1							
6100402	0.0	8							
6100501	0.0	8							
6100601	-90.0	8							
6100701	-0.201	1							
6100702	-0.470	3							
6100703	-0.6	4							
6100704	-0.682	6							
6100705	-0.5375	8							
6100801	4.57e-5	0.3187	1						
6100802	4.57e-5	0.600	6						
6100803	4.57e-5	0.2949	8						
6101001	00	8							
6101101	0000	7							
6101201	0	15390000.1607801.4	2445974.9	99999877	0.0	1			
6101202	0	15390442.1607813.9	2445975.3	99999675	0.0	2			
6101203	0	15390921.1607831.5	2446061.4	99999994	0.0	3			
6101204	0	15391858.1596982.5	2446633.1	59999999	0.0	4			
6101205	0	15394581.1584708.6	2445858.7	00000001	0.0	5			
6101206	0	15398636.1581616.9	2445762.7	712.940-9	0.0	6			
6101207	0	15402261.1581131.6	2445676.8	16.3771-6	0.0	7			
6101208	0	15405460.1575430.8	2445601.1	11.8471-6	0.0	8			

-A.18-

7210218	8.8e6	0.405	0.0	0.0
7210219	9.0e6	0.379	0.0	0.0
7210220	9.2e6	0.352	0.0	0.0
7210221	9.4e6	0.319	0.0	0.0
7210222	9.6e6	0.289	0.0	0.0
7210223	9.8e6	0.255	0.0	0.0
7210224	10.0e6	0.202	0.0	0.0
7210225	10.2e6	0.124	0.0	0.0
7210226	10.35e6	0.0	0.0	0.0

*

*7500000	ilsi	tmdpv0l							
*7500101	4.375	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*7500200	3								
*7500201	0.0	1.013e+5	310.00						

*

*7220000	ilsi	tmdpj0n							
*7220101	750000000	152000000	2.552e-3						
*7210200	1	511	p	152010000					
*7220201	-1.0	0.0	0.0	0.0					
*7220202	0.0	0.0	0.0	0.0					
*7220203	0.0	1.388	0.0	0.0					
*7220204	6.0e6	1.388	0.0	0.0					
*7220205	6.2e6	1.343	0.0	0.0					
*7220206	6.4e6	1.305	0.0	0.0					
*7220207	6.6e6	1.268	0.0	0.0					
*7220208	6.8e6	1.238	0.0	0.0					
*7220209	7.0e6	1.200	0.0	0.0					
*7220210	7.2e6	1.155	0.0	0.0					
*7220211	7.4e6	1.125	0.0	0.0					
*7220212	7.6e6	1.080	0.0	0.0					
*7220213	7.8e6	1.043	0.0	0.0					
*7220214	8.0e6	0.998	0.0	0.0					
*7220215	8.2e6	0.953	0.0	0.0					
*7220216	8.4e6	0.900	0.0	0.0					
*7220217	8.6e6	0.855	0.0	0.0					
*7220218	8.8e6	0.810	0.0	0.0					
*7220219	9.0e6	0.758	0.0	0.0					
*7220220	9.2e6	0.705	0.0	0.0					
*7220221	9.4e6	0.638	0.0	0.0					
*7220222	9.6e6	0.578	0.0	0.0					
*7220223	9.8e6	0.510	0.0	0.0					
*7220224	10.0e6	0.405	0.0	0.0					
*7220225	10.2e6	0.248	0.0	0.0					
*7220226	10.35e6	0.0	0.0	0.0					

7300000	ilchrq	tmdpv0l							
7300101	4.375	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

7300200	3				
7300201	0.0	1.013e-5	300.00		

*

7310000	ilchrq	tmdpj0n							
7310101	730000000	740000000	2.552e-3						
7310200	1	505	p	448010000					
7310201	-1.0	0.0	0.0	0.0					
7310202	0.0	0.0	0.0	0.0					
7310203	0.0	0.13	0.0	0.0					
7310204	15.0e6	0.13	0.0	0.0					

*

7400000	ileccsin	snglv0l							
7400101	2.552e-3	16.0	0.0	0.0	0.0	0.0	0.0	3.333e-5	
7400102	0.0	0.0							
7400200	0	15598371.	83230.665	2445532.2	0.0				

*

7700000	bisi	tmdpv0l							
7700101	4.375	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7700200	3								
7700201	0.0	1.013e-5	293.15						

*

* eccs flows from zion deck, assume even flow split between loops

*

7710000	bisi	tmdpj0n							
7710101	770000000	790000000	2.552e-3						
7710200	1	512	p	248010000					
7710201	-1.0	0.0	0.0	0.0					
7710202	0.0	0.0	0.0	0.0					
7710203	0.0	0.694	0.0	0.0					
7710204	6.0e6	0.694	0.0	0.0					
7710205	6.2e6	0.671	0.0	0.0					
7710206	6.4e6	0.6525	0.0	0.0					
7710207	6.6e6	0.634	0.0	0.0					
7710208	6.8e6	0.619	0.0	0.0					
7710209	7.0e6	0.600	0.0	0.0					
7710210	7.2e6	0.577	0.0	0.0					
7710211	7.4e6	0.562	0.0	0.0					
7710212	7.6e6	0.540	0.0	0.0					
7710213	7.8e6	0.521	0.0	0.0					
7710214	8.0e6	0.499	0.0	0.0					
7710215	8.2e6	0.476	0.0	0.0					
7710216	8.4e6	0.450	0.0	0.0					
7710217	8.6e6	0.427	0.0	0.0					


```

7710218      8.8e6      0.405      0.0      0.0
7710219      9.0e6      0.379      0.0      0.0
7710220      9.2e6      0.352      0.0      0.0
7710221      9.4e6      0.319      0.0      0.0
7710222      9.6e6      0.289      0.0      0.0
7710223      9.8e6      0.255      0.0      0.0
7710224     10.0e6      0.202      0.0      0.0
7710225     10.2e6      0.124      0.0      0.0
7710226     10.35e6      0.0      0.0      0.0
*
*****
7800000      blchrg      tmdpv0l
7800101      4.375      10.0 0.0 0.0 0.0 0.0 0.0 0.0
7800200      3
7800201      0.0      1.013e+5      293.15
*
*****
7810000      blchrg      tmdpj0n
7810101      7800000000 7900000000 2.552e-3
7810200      1 505 p 248010000
7810201      -1.0      0.0      0.0      0.0
7810202      0.0      0.0      0.0      0.0
7810203      0.0      0.13      0.0      0.0
7810204      15.0e6      0.13      0.0      0.0
*
*****
7900000      bleccsln      snglv0l
7900101      9.079e-4      16.0 0.0 0.0 0.0 0.0 3.333e-5
7900102      0.0 00
7900200      0 15488401. 83231.356 2445531.5 0.0
*
*****
* common steam header to jet condensor
*****
*
8000000      header1      snglv0l
8000101      0.00741      3.2 0.0 0.0 0.0 0.0 4.57e-5
8000102      0.0 00
8000200      0 6728063.0 1261843.5 2581117.8 .99983487
*
*****
8010000      headv1v      valve
8010101      800010000 804000000 0.00741 0.0 0.0 0000
8010201      0 2.8818423 10.014497 0.0 * 2.7468959
8010300      trpv1v
8010301      583
*
*****
8030000      trbbpv1v      valve
8030101      8000000000 8080000000 5.56e-4 0.0 0.0 0100
8030201      0 0.0 0.0 0.0 * 0.0
8030300      srvv1v
8030301      40
*
*****
8040000      header2      snglv0l
8040101      0.00741 3.2 0.0 0.0 0.0 0.0 4.57e-5
8040102      0.0 00
8040200      0 6710989.5 1261492.4 2581112.5 .99991458
*
*****
8050000      thrv1v      valve
8050101      804010000 8120000000 0.00741 0.0 0.0 0100
8050201      0 8.6399460 20.055846 0.0 * 5.4949115
8050300      srvv1v
8050301      805
*
*****
8080000      trbbp1n      snglv0l
8080101      0.00741 13.3305 0.0 0.0 0.0 0.0 4.57e-5
8080102      0.0971 00
8080200      0 6658740.0 1262372.2 2580999.5 .99988891
*
*****
8090000      bplnjc      snglj0n
8090101      808010000 8160000000 0.00741 0.0 0.0 0100
8090201      0 2.13640-3 -237.33-9 0.0 * 1.23347-6
*
*****
8120000      trbthrln      snglv0l
8120101      0.00741 8.730 0.0 0.0 0.0 0.0 4.57e-5
8120102      0.0971 00
8120200      0 6506022.4 1248286.1 2583199.0 .99913646
*
*****
8130000      thr1njc      snglj0n
8130101      812010000 8200000000 0.00741 0.0 0.0 0100
8130201      0 8.3986178 20.802777 0.0 * 5.4948355
*
*****
8160000      jctdv1      tmdpv0l
8160101      1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 0.0
8160200      2
8160201      0.0 6.54e+6 1.0
*
*****

```

```

8200000 jctdv2 tndpvol
8200101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
8200200 2
8200201 0.0 6.54e+6 1.0

```

```

*
*****
* containment volume for environmental heat losses
*****

```

```

9000000 envsink snglvol
9000101 2000. 100. 0.0 0.0 0.0 0.0 4.57e-5
9000102 0.0 0.0
9000200 0 1.034e5 322.0 1.0

```

```

*
9100000 envsijn sngljun
9100101 900010000 920000000 0.00741 0.0 0.0 0100
9100201 1 1.0e-5 1.0e-5 0.0

```

```

*
9200000 envsink tndpvol
9200101 2000. 100. 0.0 0.0 0.0 0.0 0.0 0 10
9200200 4
9200201 0.0 1.034e5 322.0 1.0

```

```

*****
* boundary system for steady state
*****

```

```

*
9900000 bdryvol tndpvol
9900101 0.255 0.69 0.0 0.0 0.0 0.0 0.0 0.0 0000
9900200 2
9900201 0.0 1.538e+7 1.0

```

```

*
9890000 bdryvlv valve
9890101 990000000 610000000 1.0 0.0 0.0 0000
9890201 0 1.62936-3 5.59379-6 0.0
9890300 trpvlv
9890301 599

```

```

*
*****
* reactor vessel heat structures
*****

```

```

*
*****
* 100-1: vessel wall above nozzles, below upper head flange
*****

```

```

*
11001000 1 7 2 1 0.320
11001100 0 1
11001101 1 0.323

```

```

11001102 4 0.476
11001103 1 0.601
11001201 5 1
11001202 6 5
11001203 9 6
11001301 0.0 6
11001400 0
11001401 562.2 7
11001501 100010000 0 1 1 0.823 1
11001601 900010000 0 1 1 0.823 1
11001701 0 0 0 0 1
11001801 0 10.0 10.0 0.0 0.0 0.0 1 1
11001901 0 10.0 10.0 0.0 0.0 0.0 1 1

```

```

*
*****
* 104-1: reactor vessel wall below nozzles
*****

```

```

*
11041000 12 7 2 1 0.320
11041100 0 1
11041101 1 0.323
11041102 4 0.381
11041103 1 0.506
11041201 5 1
11041202 6 5
11041203 7 6
11041301 0.0 6
11041400 0
11041401 562.2 7
11041501 104010000 0 1 1 0.600 1
11041502 108010000 0 1 1 0.677 2
11041503 108020000 0 1 1 0.867 3
11041504 108030000 10000 1 1 0.610 9
11041510 108090000 0 1 1 1.2588 10
11041511 112010000 0 1 1 0.445 11
11041512 116010000 0 1 1 0.4762 12
11041601 900010000 0 1 1 0.600 1
11041602 900010000 0 1 1 0.677 2
11041603 900010000 0 1 1 0.867 3
11041604 900010000 0 1 1 0.610 9
11041610 900010000 0 1 1 1.2588 10
11041611 900010000 0 1 1 0.445 11
11041612 900010000 0 1 1 0.4762 12
11041701 0 0 0 0 12
11041801 0 10.0 10.0 0.0 0.0 0.0 1 12
11041901 0 10.0 10.0 0.0 0.0 0.0 1 12

```

```

*****
* 112-1: vessel bottom and flange

```

```

*****
*
11121000 1 7 1 1 0.0
11121100 0 1
11121101 1 0.003
11121102 4 0.724
11121103 1 0.849
11121201 5 1
11121202 6 5
11121203 9 6
11121301 0.0 6
11121400 0
11121401 562.2 7
11121501 112010000 0 1 0 0.686 1
11121601 900010000 0 1 1 0.686 1
11121701 0 0 0 0 1
11121801 0 10.0 10.0 0.0 0.0 0.1 1
11121901 0 10.0 10.0 0.0 0.0 0.1 1
*****

```

* 112-2: heater rods, below heated section

```

*****
*
11122000 3 4 2 1 0.0
11122100 0 1
11122101 1 0.002
11122102 1 0.00295
11122103 1 0.00375
11122201 3 1
11122202 1 2
11122203 4 3
11122301 0.0 3
11122400 0
11122401 562.2 4
11122501 0 0 0 1 731.2 1
11122502 0 0 0 1 556.2 2
11122503 0 0 0 1 1470.3 3
11122601 112010000 0 1 1 731.2 1
11122602 115010000 0 1 1 556.2 2
11122603 120010000 0 1 1 1470.3 3
11122701 0 0 0 0 3
11122901 0 10.0 10.0 0.0 0.0 0.1 3
*****

```

* 120-1: core barrel

```

*****
*
11201000 12 5 2 1 0.257
11201100 0 1
11201101 4 0.267

```

```

11201201 5 4
11201301 0.0 4
11201400 0
11201401 562.2 5
11201501 120010000 0 1 1 1.2588 1
11201502 124010000 10000 1 1 0.610 7
11201503 125010000 0 1 1 0.867 8
11201504 132010000 0 1 1 0.677 9
11201505 136010000 0 1 1 0.600 10
11201506 140010000 0 1 1 0.3674 11
11201507 144010000 0 1 1 0.897 12
11201601 108090000 0 1 1 1.2588 1
11201602 108080000 -10000 1 1 0.6100 7
11201603 108020000 0 1 1 0.867 8
11201604 108010000 0 1 1 0.677 9
11201605 104010000 0 1 1 0.600 10
11201606 100010000 0 1 1 0.3674 11
11201607 100010000 0 1 1 0.897 12
11201701 0 0 0 0 12
11201801 0 10.0 10.0 0.0 0.0 0.1 12
11201901 0 10.0 10.0 0.0 0.0 0.0 1. 12

```

* 124-1: heated section of heater rods

```

*****
*
11241000 6 9 2 1 0.0
11241100 0 1
11241101 2 0.00200
11241102 2 0.00260
11241103 2 0.00375
11241104 2 0.00475
11241201 7 2
11241202 2 4
11241203 1 6
11241204 4 8
11241301 0.0 2
11241302 1.0 4
11241303 0.0 8
11241400 0
11241401 600.6 9
11241501 0 0 0 1 649.00 6
11241601 124010000 10000 1 1 649.00 6
11241701 888 0.08568 0.0 0.0 1
11241702 888 0.17532 0.0 0.0 2
11241703 888 0.23900 0.0 0.0 3
11241704 888 0.23900 0.0 0.0 4
11241705 888 0.17532 0.0 0.0 5

```

11241706	888	0.08568	0.0	0.0	6				
11241901	0	0.305	3.355	0	0	0	0	1.0	1
11241902	0	0.915	2.745	0	0	0	0	1.0	2
11241903	0	1.525	2.135	0	0	0	0	1.0	3
11241904	0	2.135	1.525	0	0	0	0	1.0	4
11241905	0	2.745	0.915	0	0	0	0	1.0	5
11241906	0	3.355	0.305	0	0	0	0	1.0	6

*

* 124-2: unheated instrument rods

11242000	6	6	2	1	0.0				
11242100	0	1							
11242101	3	0.00432							
11242102	2	0.00612							
11242201	1	2							
11242202	5	5							
11242301	0.0	5							
11242400	0								
11242401	600.6	6							
11242501		0	0	0	1	63.44	6		
11242601	124010000	10000	1	1	63.44	6			
11242701	0	0	0	0	6				
11242901	0	10.0	10.0	0.0	0.0	0.1	6		

*

* 128-1: upper plenum internals

11281000	1	5	1	1	0.0				
11281100	0	1							
11281101	4	0.023							
11281201	5	4							
11281301	0.0	4							
11281400	0								
11281401	584.2	5							
11281501	128010000		0	1	0	0.773	1		
11281601	128010000		0	1	0	0.773	1		
11281701	0	0	0	0	1				
11281801	0	10.0	10.0	0.0	0.0	0.1	1		
11281901	0	10.0	10.0	0.0	0.0	0.1	1		

*

* 132-1: guide tubes

11321000	5	4	2	1	0.04405				
----------	---	---	---	---	---------	--	--	--	--

11321100	0	1							
11321101	3	0.04655							
11321201	5	3							
11321301	0.0	3							
11321400	0								
11321401	600.6	4							
11321501	156020000		0	1	1	5.406	1		
11321502	156020000		0	1	1	4.800	2		
11321503	156010000		0	1	1	2.939	3		
11321504	156010000		0	1	1	7.176	4		
11321505	156010000		0	1	1	5.800	5		
11321601	132010000		0	1	1	5.406	1		
11321602	136010000		0	1	1	4.800	2		
11321603	140010000		0	1	1	2.939	3		
11321604	144010000		0	1	1	7.176	4		
11321605	148010000		0	1	1	5.800	5		
11321701	0	0	0	0	0	5			
11321801	0	10.0	10.0	0.0	0.0	0.1	5		
11321901	0	10.0	10.0	0.0	0.0	0.1	5		

* 144-1: upper core support plate

11441000	1	9	1	1	0.0				
11441100	0	1							
11441101	8	0.304							
11441201	5	8							
11441301	0.0	8							
11441400	0								
11441401	562.2	9							
11441501	144010000		0	1	0	0.156	1		
11441601	140010000		0	1	0	0.156	1		
11441701	0	0	0	0	1				
11441801	0	10.0	10.0	0.0	0.0	0.1	1		
11441901	0	10.0	10.0	0.0	0.0	0.1	1		

*

* 148-1: reactor vessel wall above upper plenum flange

11481000	1	7	2	1	0.320				
11481100	0	1							
11481101	1	0.323							
11481102	4	0.522							
11481103	1	0.647							
11481201	5	1							
11481202	6	5							
11481203	9	6							

11481301	0.0	6					
11481400	0						
11481401	562.2	7					
11481501	148010000		0	1	1	0.404	1
11481601	900010000		0	1	1	0.404	1
11481701	0	0	0	0	1		
11481801	0	10.0	10.0	0	0.0	0.0	1.1
11481901	0	10.0	10.0	0	0.0	0.0	1.1

*

* 152-1: reactor vessel upper head

*

11521000	1	7	3	1	0.320		
11521100	0	1					
11521101	1	0.324					
11521102	4	0.354					
11521103	1	0.479					
11521201	5	1					
11521202	6	5					
11521203	9	6					
11521301	0.0	6					
11521400	0						
11521401	562.2	7					
11521501	152010000		0	1	1	0.5	1
11521601	900010000		0	1	1	0.5	1
11521701	0	0	0	0	1		
11521801	0	10.0	10.0	0	0.0	0.0	1.1
11521901	0	10.0	10.0	0	0.0	0.0	1.1

*

*

* loop heat structures

*

* ht str no. 212-1 blsg inlet/outlet plnm hemisph

12121000	2	6	3	1	0.377	0	
12121100		0		1			
12121101		1		0.380			
12121102		2		0.430			
12121103		2		0.555			
12121201		5		1			
12121202		6		3			
12121203		9		5			
12121301		0.0		5			
12121400				-1			
12121401	583.000	583.000	583.000	583.000	583.000	583.000	

*	583.000						
12121402	557.000	557.000	557.000	557.000	557.000	557.000	
*	557.000						
12121501	212010000	0	1	1	0.1872	1	
12121502	228010000	0	1	1	0.1872	2	
12121601	900010000	0	1	1	0.1872	2	
12121701	0	0	0	0	0	2	
12121801	0	10.0	10.0	0	0.0	0.1	2
12121901	0	10.0	10.0	0	0.0	0.1	2

*

* ht str no. 212-2 blsg inlet/outlet plnm walls

12122000	4	6	2	1	0.365	0	
12122100		0		1			
12122101		1		0.368			
12122102		2		0.434			
12122103		2		0.559			
12122201		5		1			
12122202		6		3			
12122203		9		5			
12122301		0.0		5			
12122400				-1			
12122401	583.000	583.000	583.000	583.000	583.000	583.000	
*	583.000						
12122402	557.000	557.000	557.000	557.000	557.000	557.000	
*	557.000						
12122403	583.000	583.000	583.000	583.000	583.000	583.000	
*	583.000						
12122404	557.000	557.000	557.000	557.000	557.000	557.000	
*	557.000						
12122501	212010000	0	1	1	0.4237	1	
12122502	228010000	0	1	1	0.4237	2	
12122503	216010000	0	1	1	1.1035	3	
12122504	224010000	0	1	1	1.1035	4	
12122601	900010000	0	1	1	0.4237	2	
12122602	900010000	0	1	1	1.1035	4	
12122701	0	0	0	0	0	4	
12122801	0	10.0	10.0	0	0.0	0.1	2
12122802	0	10.0	10.0	0	0.0	0.1	4
12122901	0	10.0	10.0	0	0.0	0.1	4

*

* ht str no. 220-2 blsg inlet/outlet tube sheet

12202000	2	4	2	1	0.0098	0	
12202100		0		1			
12202101		3		0.0163			

13001601	900010000	0	1	1	9.0016	1
13001602	900010000	0	1	1	8.3920	2
13001603	900010000	0	1	1	10.2616	4
13001604	900010000	0	1	1	10.2380	5
13001701	0	0	0	0	0	5
13001801	0	10.0	10.0	0	0	1. 5
13001901	0	10.0	10.0	0	0	1. 5

* ht str no. 300-2 blsg upper dc to separator						

13002000	2	2	2	1	0.2514	0
13002100	0			1		
13002101	1			0.2554		
13002201	5			1		
13002301	0.0			1		
13002400				0		
13002401	560			2		
13002501	304050000	0	1	1	0.6461	1
13002502	308010000	0	1	1	2.120	2
13002601	300010000	0	1	1	0.6461	1
13002602	308010000	0	1	1	2.120	2
13002701	0	0		0	0	2
13002801	0	10.0	10.0	0	0	1. 2
13002901	0	10.0	10.0	0	0	1. 1
13002902	0	10.0	10.0	0	0	1. 2

* ht str no. 300-3 blsg upper sg shell to environ						

13003000	4	6	2	1	0.4375	0
13003100	0			1		
13003101	1			0.4405		
13003102	2			0.4785		
13003103	2			0.6035		
13003201	5			1		
13003202	6			3		
13003203	9			5		
13003301	0.0			5		
13003400				0		
13003401	530			6		
13003501	300010000	0	1	1	0.6461	1
13003502	304050000	0	1	1	1.0104	2
13003503	312010000	0	1	1	2.120	3
13003504	316010000	0	1	1	3.4278	4
13003601	900010000	0	1	1	0.6461	1
13003602	900010000	0	1	1	1.0104	2
13003603	900010000	0	1	1	2.120	3

14003506	452010000	10000	1	1	0.9752	7	14122401	583.000	583.000	583.000	583.000	583.000
14003601	900010000	0	1	1	1.0562	1	+	583.000				
14003602	900010000	0	1	1	1.1067	2	14122402	557.000	557.000	557.000	557.000	557.000
14003603	900010000	0	1	1	1.3125	3	+	557.000				
14003604	900010000	0	1	1	0.647	4	14122403	583.000	583.000	583.000	583.000	583.000
14003605	900010000	0	1	1	0.878	5	+	583.000				
14003606	900010000	0	1	1	0.9752	7	14122404	557.000	557.000	557.000	557.000	557.000
14003701	0	0	0	0	0	7	+	557.000				
14003801	0	10.0	10.0	0	0	0	14122501	412010000	0	1	1	0.4237
14003901	0	10.0	10.0	0	0	0	14122502	430010000	0	1	1	0.4237
*							14122503	416010000	0	1	1	1.1035
*****							14122504	424010000	0	1	1	1.1035
*	ht str no. 412-1	ilsg inlet/outlet	plnm	hemisph			14122601	900010000	0	1	1	0.4237
*****							14122602	900010000	0	1	1	1.1035
14121000	2	6	3	1	0.377	0	14122701	0	0	0	0	4
14121100		0		1			14122801	0	10.0	10.0	0	0
14121101		1		0.380			14122802	0	10.0	10.0	0	0
14121102		2		0.430			14122901	0	10.0	10.0	0	0
14121103		2		0.555			*					
14121201		5		1			*****					
14121202		6		3			*****					
14121203		9		5			*	ht str no. 420-1	intact loop	sg tubes		
14121301	0.0			5			*****					
14121400				-1			*					
14121401	583.000	583.000	583.000	583.000	583.000		14201000	8	8	2	1	0.00980
+	583.000						14201100	0	1			
14121402	557.000	557.000	557.000	557.000	557.000		14201101	7	0.0127			
+	557.000						14201201	5	7			
14121501	412010000	0	1	1	0.1872	1	14201301	0.0	7			
14121502	430010000	0	1	1	0.1872	2	14201400	0				
14121601	900010000	0	1	1	0.1872	2	14201401	562.4	8			
14121701	0	0	0	0	0	2	14201501	420010000	0	1	1	359.04
14121801	0	10.0	10.0	0	0	0	14201502	420020000	10000	1	1	361.72
14121901	0	10.0	10.0	0	0	0	14201503	420040000	10000	1	1	306.36
*							14201504	422010000	10000	1	1	361.72
*****							14201505	422030000	0	1	1	359.04
*	ht str no. 412-2	ilsg inlet/outlet	plnm	walls			14201601	504010000	0	1	1	359.04
*****							14201602	504020000	10000	1	1	361.72
14122000	4	6	2	1	0.365	0	14201603	504040000	0	1	1	306.36
14122100		0		1			14201604	504030000	-10000	1	1	361.72
14122101		1		0.368			14201605	504010000	0	1	1	359.04
14122102		2		0.434			14201701	0	0	0	0	8
14122103		2		0.559			14201801	0	10.0	10.0	0.0	0
14122201		5		1			14201901	0	10.0	10.0	0.0	0
14122202		6		3			*					
14122203		9		5			*****					
14122301	0.0			5			*	ht str no. 420-2	ilsg inlet/outlet	tube sheet		
14122400				-1			*****					

14202000	2	4	2	1	0.0098	0	
14202100		0		1			
14202101		3		0.0163			
14202201		5		3			
14202301		0.0		3			
14202400				-1			
14202401	583.000	583.000	583.000	583.000			
14202402	557.000	557.000	557.000	557.000			
14202501	420010000	0	1	1	45.40	1	
14202502	422030000	0	1	1	45.40	2	
14202601	0	0	0	1	45.40	2	
14202701	0	0	0	0	0	2	
14202801	0	10.0	10.0	0	0	0	0. 1. 2

* ht str no. 421-1 intact loop sg tubes

*14211000	8	8	2	1	0.00980	
*14211100	0	1				
*14211101	7	0.0127				
*14211201	5	7				
*14211301	0.0	7				
*14211400	0					
*14211401	562.4	8				
*14211501	428010000	0	1	1	2.8724	1
*14211502	428020000	10000	1	1	2.5654	3
*14211503	428040000	10000	1	1	2.1728	5
*14211504	419010000	10000	1	1	2.5654	7
*14211505	419030000	0	1	1	2.8724	8
*14211601	504010000	0	1	1	2.8724	1
*14211602	504020000	10000	1	1	2.5654	3
*14211603	504040000	0	1	1	2.1728	5
*14211604	504030000	-10000	1	1	2.5654	7
*14211605	504010000	0	1	1	2.8724	8
*14211701	0	0	0	0	8	
*14211801	0	10.0	10.0	0.0	0.0	0. 1. 8
*14211901	0	10.0	10.0	0.0	0.0	0. 1. 8

* ht str no. 421-2 ilsg inlet/outlet tube sheet

*14212000	2	4	2	1	0.0098	0
*14212100		0		1		
*14212101		3		0.0163		
*14212201		5		3		
*14212301		0.0		3		
*14212400				-1		
*14212401	583.000	583.000	583.000	583.000		

*14212402	557.000	557.000	557.000	557.000			
*14212501	428010000	0	1	1	2.8724	1	
*14212502	419030000	0	1	1	2.8724	2	
*14212601	0	0	0	1	2.8724	2	
*14212701	0	0	0	0	0	2	
*14212801	0	10.0	10.0	0	0	0	0. 1. 2

* ht str no. 500-1 ilsg external dc pipe to environ

15001000	5	5	2	1	0.0486	0	
15001100		0		1			
15001101		2		0.0572			
15001102		2		0.1572			
15001201		5		2			
15001202		9		4			
15001301		0.0		4			
15001401		564.0		5			
15001501	500010000	0	1	1	9.0016	1	
15001502	500020000	0	1	1	8.3920	2	
15001503	500030000	10000	1	1	10.2616	4	
15001504	500050000	0	1	1	10.2380	5	
15001601	900010000	0	1	1	9.0016	1	
15001602	900010000	0	1	1	8.3920	2	
15001603	900010000	0	1	1	10.2616	4	
15001604	900010000	0	1	1	10.2380	5	
15001701		0	0	0	0	5	
15001801		0	10.0	10.0	0	0	0. 1. 5
15001901		0	10.0	10.0	0	0	0. 1. 5

* ht str no. 500-2 ilsg upper dc to separator

15002000	2	2	2	1	0.2514	0	
15002100		0		1			
15002101		1		0.2554			
15002201		5		1			
15002301		0.0		1			
15002400				0			
15002401		560		2			
15002501	504050000	0	1	1	0.6461	1	
15002502	508010000	0	1	1	2.120	2	
15002601	500010000	0	1	1	0.6461	1	
15002602	508010000	0	1	1	2.120	2	
15002701		0	0	0	0	2	
15002801		0	10.0	10.0	0	0	0. 1. 2
15002901		0	10.0	10.0	0	0	0. 1. 1
15002902		0	10.0	10.0	0	0	0. 1. 2

* ht str no. 500-3 ilsg upper sg shell to environ									

15003000	4	6	2	1	0.4375	0			
15003100		0		1					
15003101		1			0.4405				
15003102		2			0.4785				
15003103		2			0.6035				
15003201		5		1					
15003202		6		3					
15003203		9		5					
15003301		0.0		5					
15003400				0					
15003401		530.		6					
15003501	500010000	0	1	1	0.6461	1			
15003502	504050000	0	1	1	1.0104	2			
15003503	512010000	0	1	1	2.120	3			
15003504	516010000	0	1	1	3.4278	4			
15003601	900010000	0	1	1	0.6461	1			
15003602	900010000	0	1	1	1.0104	2			
15003603	900010000	0	1	1	2.120	3			
15003604	900010000	0	1	1	3.4278	4			
15003701	0	0	0	0	0	4			
15003801	0.	10.0	10.0	0.	0.	0.	0.	1.	1
15003802	0.	10.0	10.0	0.	0.	0.	0.	1.	2
15003803	0.	10.0	10.0	0.	0.	0.	0.	1.	3
15003804	0.	10.0	10.0	0.	0.	0.	0.	1.	4
15003901	0.	10.0	10.0	0.	0.	0.	0.	1.	4

* ht str no. 500-4 ilsg lower sg dc to boiler									

15004000	1	2	2	1	0.345	0			
15004100		0		1					
15004101		1			0.351				
15004201		5		1					
15004301		0.0		1					
15004400				0					
15004401		560.		2					
15004501	504010000	0	1	1	1.0637	1			
15004601	500050000	0	1	1	1.0637	1			
15004701	0	0	0	0	0	1			
15004801	0.	10.0	10.0	0.	0.	0.	0.	1.	1
15004901	0.	10.0	10.0	0.	0.	0.	0.	1.	1

* ht str no. 500-5 ilsg lower sg dc wall to environ									

15005000	1	6	2	1	0.370	0			
15005100		0		1					
15005101		1			0.373				
15005102		2			0.405				
15005103		2			0.530				
15005201		5		1					
15005202		6		3					
15005203		9		5					
15005301		0.0		5					
15005400				0					
15005401		530.		6					
15005501	500050000	0	1	1	1.2637	1			
15005601	900010000	0	1	1	1.2637	1			
15005701	0	0	0	0	0	1			
15005801	0	10.0	10.0	0.	0.	0.	0.	1.	1
15005901	0.	10.0	10.0	0.	0.	0.	0.	1.	1

* ht str no. 504-1 ilsg boiler wall to environ									

15041000	5	6	2	1	0.347	0			
15041100		0		1					
15041101		1			0.350				
15041102		2			0.380				
15041103		2			0.505				
15041201		5		1					
15041202		6		3					
15041203		9		5					
15041301		0.0		5					
15041400				0					
15041401		550.		6					
15041501	504010000	0	1	1	1.2827	1			
15041502	504020000	10000	1	1	2.5654	3			
15041503	504040000	0	1	1	2.098	4			
15041504	504050000	0	1	1	0.3658	5			
15041601	900010000	0	1	1	1.2827	1			
15041602	900010000	0	1	1	2.5654	3			
15041603	900010000	0	1	1	2.098	4			
15041604	900010000	0	1	1	0.3658	5			
15041701	0	0	0	0	0	5			
15041801	0.	10.0	10.0	0.	0.	0.	0.	1.	4
15041802	0.	10.0	10.0	0.	0.	0.	0.	1.	5
15041901	0.	10.0	10.0	0.	0.	0.	0.	1.	5

* ht str no. 512-1 ilsg separator to sep bypass									

15121000	1	2	2	1	0.2982	0			

15121100	0	1							
15121101	1	0.3012							
15121201	5	1							
15121301	0.0	1							
15121400		0							
15121401	550	2							
15121501	508010000	0	1	1	1.7886	1			
15121601	512010000	0	1	1	1.7886	1			
15121701	0	0	0	0	0	1			
15121801	0	10.0	10.0	0	0	0	0.1	1	
15121901	0	10.0	10.0	0	0	0	0.1	1	

 * ht str no. 516-1 ilsg hemisph top to environ

15161000	1	6	3	1	0.447	0			
15161100	0	1							
15161101	1	0.451							
15161102	2	0.473							
15161103	2	0.598							
15161201	5	1							
15161202	6	3							
15161203	9	5							
15161301	0.0	5							
15161400		0							
15161401	550	6							
15161501	516010000	0	1	1	0.391	1			
15161601	900010000	0	1	1	0.391	1			
15161701	0	0	0	0	0	1			
15161801	0	10.0	10.0	0	0	0	0.1	1	
15161901	0	10.0	10.0	0	0	0	0.1	1	

 * ht str no. 610-1 prizer wall heat struct

16101000	7	6	2	1	0.300	0			
16101100	0	1							
16101101	1	0.303							
16101102	2	0.360							
16101103	2	0.485							
16101201	5	1							
16101202	6	3							
16101203	9	5							
16101301	0.0	5							
16101400		0							
16101401	636	6							
16101501	610020000	10000	1	1	0.475	2			
16101502	610040000	0	1	1	0.600	3			

16101503	610050000	10000	1	1	0.682	5			
16101504	610070000	10000	1	1	0.5375	7			
16101601	900010000	0	1	1	0.475	2			
16101602	900010000	0	1	1	0.600	3			
16101603	900010000	0	1	1	0.682	5			
16101604	900010000	0	1	1	0.5375	7			
16101701	0	0	0	0	0	7			
16101801	0	10.0	10.0	0	0	0	0.1	5	
16101802	0	10.0	10.0	0	0	0	0.1	7	
16101901	0	10.0	10.0	0	0	0	0.1	7	

 * ht str no. 610-2 prizer top (hemisph) heat struct

16102000	1	6	3	1	0.323	0			
16102100	0	1							
16102101	1	0.326							
16102102	2	0.383							
16102103	2	0.508							
16102201	5	1							
16102202	6	3							
16102203	9	5							
16102301	0.0	5							
16102400		0							
16102401	636	5							
16102402	636	6							
16102501	610010000	0	1	1	0.311	1			
16102601	900010000	0	1	1	0.311	1			
16102701	0	0	0	0	0	1			
16102801	0	10.0	10.0	0	0	0	0.1	1	
16102901	0	10.0	10.0	0	0	0	0.1	1	

 * ht str no. 610-3 prizer bot (flange) heat struct

16103000	1	6	1	1	0.0	0			
16103100	0	1							
16103101	1	0.003							
16103102	2	0.8374							
16103103	2	0.9624							
16103201	5	1							
16103202	6	3							
16103203	9	5							
16103301	0.0	5							
16103400		0							
16103401	636	6							
16103501	610080000	0	1	1	0.2731	1			
16103601	900010000	0	1	1	0.2731	1			


```

20100252 1073.15 4.61e+6 1173.15 4.73e+6 1273.15 4.95e+6
20100253 1473.15 5.29e+6 10000.0 5.29e+6
*
* copper
20100351 3.43e6
*
* inconel 600
20100451 373.15 3.94e+6 573.15 4.18e+6 873.15 4.71e+6
20100452 1173.15 5.17e+6
*
*stainless steel
20100551 273.15 3.83e+6 366.5 3.83e+6 477.59 4.19e+6
20100552 588.59 4.336e+6 699.82 4.504e+6 810.93 4.639e+6
20100553 922.04 4.773e+6 1144.26 5.076e+6 1366.5 5.376e+6
20100554 1477.59 5.546e+6 10000.0 5.546e+6
*
* aluminum oxide
20100751 373.15 3.015e+6 473.15 3.482e+6 573.15 3.796e+6
20100752 673.15 3.946e+6 773.15 4.093e+6 873.15 4.239e+6
20100753 973.15 4.384e+6 1073.16 4.373e+6 1173.16 4.529e+6
20100754 1373.16 4.529e+6 1473.16 4.685e+6
*
* rockwool
20100951 1.36e+5
*
*****
* core power
*****
*
20288800 power 501
20288801 -1.0 10.00e+6
20288802 0.0 10.00e+6
20288803 10.0 10.00e+6
20288804 13.94 10.00e+6
20288805 15.0 8.5093e+6
20288806 20.0 5.5464e+6
20288807 30.0 3.6521e+6
20288808 40.0 3.0656e+6
20288809 50.0 2.6580e+6
20288810 60.0 2.5579e+6
20288811 80.0 2.3982e+6
20288812 100.0 2.3092e+6
20288813 150.0 2.0900e+6
20288814 200.0 2.0261e+6
20288815 300.0 1.8832e+6
20288816 400.0 1.7569e+6
20288817 500.0 1.6865e+6

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20288818 600.0 1.6257e+6
20288819 800.0 1.5419e+6
20288820 1000.0 1.5357e+6
20288821 1500.0 1.3603e+6
20288822 2000.0 1.2058e+6
20288823 3000.0 1.0656e+6
20288824 4000.0 0.97510e+6
20288825 5000.0 0.91049e+6
20288826 6000.0 0.86154e+6
20288827 8000.0 0.79102e+6
20288828 10000.0 0.74152e+6
20288829 20000.0 0.61196e+6
20288830 50000.0 0.47759e+6
20288831 100000.0 0.39343e+6
*
*****
* pressurizer heater power
*****
*
20260000 reac-t * backup heaters
20260001 15.34e6 1.125e5
20260002 15.40e6 1.125e5
20260003 15.40e6 0.0
*
20260100 reac-t * proportional heaters
20260101 15.41e6 7.5e3
20260102 15.62e6 0.0
*
*****
* control systems
*****
*
*****
* calculate time step
*****
*
20500100 "time stp" sum 1.0000000 20000000 1
20500101 0.0 1.0 time 0
20500102 -1.0 cntrlvar 2
*
20500200 "old time" mult 1.0000000 0.0 1
20500201 time 0
*
*****
* control system turbine bypass valve control *
* during loca calculations *
* based on mean primary temperature control *
*****

```

```

*
*****
* calculate il + bl mean temperature and select the larger
*****
*
20503000 "ilmtmp"      sum      1.0000000 580.37388 1
20503001  0.0      0.5  tempf  452010000
20503002      0.5  tempf  400010000
*
20503100 "blmtmp"      sum      1.0000000 580.35764 1
20503101  0.0      0.5  tempf  252010000
20503102      0.5  tempf  200010000
*
20503200 "ilmtmpl"      tripunit 1.0000000 1.0000000 1
20503201  514
*
20503300 "blmtmpl"      tripunit 1.0000000 0.0      1
20503301  516
*
20503400 "cilmtmp"      mult      1.0000000 580.37388 1
20503401  cntrlvar 32      cntrlvar 30
*
20503500 "blmtmpl"      mult      1.0000000 0.0      1
20503501  cntrlvar 33      cntrlvar 31
*
20503600 "pmtmp"      sum      1.0000000 580.37388 1
20503601  0.0      1.0  cntrlvar 34
20503602      1.0  cntrlvar 35
*
*****
* input to tb valve control after core trip-pmt setpt = 564.9 k
*****
*
20503700 "pmtterra"      sum      -.0902500 1.1456230 1
20503701  566.3      -1.0  cntrlvar 36
*
*****
* check for reactor scram
*****
*
20503800 "arcttrp"      tripunit 1.0000000 0.0      1
20503801  501
*
20503900 "arcttrpc"      mult      1.0000000 0.0      1
20503901  cntrlvar 38      cntrlvar 37
*
*****
* tb valve control

```

```

*****
*
20504000 "thp area"      sum      1.0000000 0.0      1
*
*      3      0.0      1.0000000
20504001  0.0      1.0      cntrlvar 39
*
*****
* calculate core collapsed liquid level
*****
*
20512400 "core lvl"      sum      1.0000000 3.6600000 1
20512401      0.0      0.610      voidf 124010000
20512402      0.610      voidf 124020000
20512403      0.610      voidf 124030000
20512404      0.610      voidf 124040000
20512405      0.610      voidf 124050000
20512406      0.610      voidf 124060000
*
*****
* calculate core collapsed liquid level ---vessel---
*****
*
20512500 "core lvl"      sum      1.0000000 5.8027000 1
20512501      0.0      0.610      voidf 124010000
20512502      0.610      voidf 124020000
20512503      0.610      voidf 124030000
20512504      0.610      voidf 124040000
20512505      0.610      voidf 124050000
20512506      0.610      voidf 124060000
20512507      0.867      voidf 128010000
20512508      0.6757     voidf 132010000
20512509      0.6      voidf 136010000
*
*****
* calculate core heat input
*****
*
20512600 "coreheat"      sum      1.0000000 -6 9.8651798 1
20512601      0.0      1.0      q      124010000
20512602      1.0      q      124020000
20512603      1.0      q      124030000
20512604      1.0      q      124040000
20512605      1.0      q      124050000
20512606      1.0      q      124060000
*
*****
* calculate vessel dc collapsed level
*****
*

```

20510900	"vsldclvl"	sum	1.000000 3.660000 1
20510901	0.0 0.610	voidf	108030000
20510902	0.610	voidf	108040000
20510903	0.610	voidf	108050000
20510904	0.610	voidf	108060000
20510905	0.610	voidf	108070000
20510906	0.610	voidf	108080000

 * energy transferred to generators

20530000	"blsgheat"	sum	1.000000-6 4.978364 1
20530001	0.0 1.0	q	304010000
20530002	1.0	q	304020000
20530003	1.0	q	304030000
20530004	1.0	q	304040000

20550000	"ilsgheat"	sum	1.000000-6 4.9752834 1
20550001	0.0 1.0	q	504010000
20550002	1.0	q	504020000
20550003	1.0	q	504030000
20550004	1.0	q	504040000

 * calculate sg recirculation ratios

20530100	"recircbl"	div	1.000000 5.0243769 1
20530101	mflowj 308010000	mflowj	301000000
20550100	"recircil"	div	1.000000 5.0230369 1
20550101	mflowj 508010000	mflowj	501000000

 * calculate narrow range sg liquid levels

20530800	"ilsgll "	sum	.15390000 .13184474 1
20530801	0.0 0.600	voidf	300010000
20530802	2.12	voidf	312010000
20530803	3.7778	voidf	316010000

20550800	"blsgll "	sum	.15390000 .12746200 1
20550801	0.0 0.600	voidf	500010000
20550802	2.12	voidf	512010000
20550803	3.7778	voidf	516010000

 * set il main feedwater on 9.5 m wide range sg level

20535900	"il lv er"	sum	1.000000 0. 1
20535901	2450.	-1.0 cntrlvar	309

20536100	"il feed "	sum	1.0000000 2.8000000 1
20536101	0.0 1.0	mflowj	329000000
20536102	2.0	cntrlvar	359

 * set bl main feedwater on 9.6 m wide range sg level

20555900	"bl lv er"	sum	1.000000 0. 1
20555901	2450.	-1.0 cntrlvar	509

20556100	"bl feed "	sum	1.0000000 2.8000000 1
20556101	0.0 1.0	mflowj	529000000
20556102	2.0	cntrlvar	559
*20556103	1.0	mflowj	493000000

 * pressurizer heater power

20560000	"pbkuphr"	function	1.0000000 0.0 1
20560001	p 610010000	600	

20560100	"pprohr "	function	1.0000000 836.59446 1
20560101	p 610010000	601	

20560200	"bkphtrpw"	tripunit	1.0000000 0.0 1
20560201	634		

20560300	"bkphtrpw"	mult	1.0000000 0.0 1
20560301	cntrlvar 600	cntrlvar	602

20560400	"pzhrtrpw"	sum	1.0000000 836.59446 1
20560401	0.0 1.0	cntrlvar	601
20560402	1.0	cntrlvar	603

20560500	"pzhrtrpw"	tripunit	1.0000000 0.0 1
20560501	633		

20560600	"pzhrtrpw"	mult	1.0000000 0.0 1
20560601	cntrlvar 604	cntrlvar	605

*****				20550909	0.4951	rho	504040000
*****				20550910	0.7979	rho	504050000
* calculate collapsed prssurizer liquid level				20550911	0.5720	rho	508010000
*****				20550912	0.6288	rho	512010000
*****				20550913	2.0288	rho	516010000

20561000	"pzt lev "	sum	1.00000000	2.594213			
1							
20561001	0.0	0.201	voidf	610010000	* calculate intact primary loop mass		
20561002		0.470	voidf	610020000	*****		
20561003		0.470	voidf	610030000	*****		
20561004		0.600	voidf	610040000	20570000	"ihl mass"	sum 1.0000000 2848.8553 1
20561005		0.682	voidf	610050000	20570001	0.0	0.04463902 rho 400010000
20561006		0.682	voidf	610060000	20570002		0.00093545 rho 402010000
20561007		0.5375	voidf	610070000	20570003		0.00058598 rho 404010000
20561008		0.5375	voidf	610080000	20570004		0.04665091 rho 406010000
*****				20570005		0.02373491 rho 408010000	
*****				20570006		0.01778686 rho 408020000	
* calculate broken loop steam generator mass				20570007		0.1250 rho 412010000	
*****				20570008		0.2323 rho 416010000	

20530900	"sgb mass"	sum	1.00000000	2860.9843 1	20570100	"isg mass"	sum 1.0000000 2500.0 1
20530901	0.0	0.3228	rho	300010000	20570101	0.0	0.1212112 rho 420010000
20530902		0.0621	rho	300020000	20570102		0.1082557 rho 420020000
20530903		0.0759	rho	300030000	20570103		0.1082557 rho 420030000
20530904		0.0759	rho	300040000	20570104		0.091689 rho 420040000
20530905		0.1302	rho	300050000	20570105		0.091689 rho 420050000
20530906		0.5839	rho	304010000	20570106		0.1082557 rho 422010000
20530907		0.5882	rho	304020000	20570107		0.1082557 rho 422020000
20530908		0.5882	rho	304030000	20570108		0.1212112 rho 422030000
20530909		0.4951	rho	304040000	*20570109		0.0008658 rho 428010000
20530910		0.7979	rho	304050000	*20570110		0.0007733 rho 428020000
20530911		0.5720	rho	308010000	*20570111		0.0007733 rho 428030000
20530912		0.6288	rho	312010000	*20570112		0.000655 rho 428040000
20530913		2.0288	rho	316010000	*20570113		0.000655 rho 428050000
*****				*20570114		0.0007733 rho 419010000	
*****				*20570115		0.0007733 rho 419020000	
* calculate intact loop steam generator mass				*20570116		0.0008658 rho 419030000	

*****				20570200	"ils mass"	sum 1.0000000 2500.0 1	
20550900	"sga mass"	sum	1.00000000	2848.8553 1	20570201	0.0	0.2323 rho 424010000
20550901	0.0	0.3228	rho	500010000	20570202		0.125 rho 430010000
20550902		0.0621	rho	500020000	20570203		0.0114552 rho 432010000
20550903		0.0759	rho	500030000	20570204		0.02757684 rho 432020000
20550904		0.0759	rho	500040000	20570205		0.02757684 rho 432030000
20550905		0.1302	rho	500050000	20570206		0.02757684 rho 432040000
20550906		0.5839	rho	504010000	20570207		0.02646018 rho 432050000
20550907		0.5882	rho	504020000	20570208		0.02646018 rho 436010000
20550908		0.5882	rho	504030000	20570209		0.02491284 rho 436020000

20570210	0.02611386	rho	436030000	20570701	0.0	0.122077	rho	220010000
20570211	0.02491284	rho	436040000	20570702		0.109029	rho	220020000
*				20570703		0.109029	rho	220030000
20570300 "icl mass"	sum	1.000000	2500.0	1	20570704	0.092344	rho	220040000
20570301 0.0	0.0235	rho	440010000	20570705		0.092344	rho	220050000
20570302	0.02476276	rho	444010000	20570706		0.109029	rho	220060000
20570303	0.03177573	rho	448010000	20570707		0.109029	rho	220070000
20570304	0.03286424	rho	452010000	20570708		0.122077	rho	220080000
20570305	0.03286424	rho	452020000	*				
20570306	0.040832	rho	740010000	20570800 "bis mass"	sum	1.000000	2500.0	1
*				20570801	0.0	0.2323	rho	224010000
20570400 "pr mass"	sum	1.000000	2500.0	1	20570802	0.125	rho	228010000
20570401 0.0	0.0325	rho	610010000	20570803		0.0114552	rho	232010000
20570402	0.132869	rho	610020000	20570804		0.02757684	rho	232020000
20570403	0.132869	rho	610030000	20570805		0.02757684	rho	232030000
20570404	0.169620	rho	610040000	20570806		0.02757684	rho	232040000
20570405	0.192801	rho	610050000	20570807		0.02646018	rho	232050000
20570406	0.192801	rho	610060000	20570808		0.02930844	rho	236010000
20570407	0.146791	rho	610070000	20570809		0.02491284	rho	236020000
20570408	0.146791	rho	610080000	20570810		0.02534574	rho	236030000
20570409	0.02382748	rho	600010000	20570811		0.02491284	rho	236040000
20570410	0.03249617	rho	600020000	*				
20570411	0.01905868	rho	600030000	20570900 "bcl mass"	sum	1.000000	2500.0	1
20570412	0.00791779	rho	620010000	20570901	0.0	0.0235	rho	240010000
20570413	0.00791779	rho	620020000	20570902		0.03558394	rho	244010000
*				20570903		0.04025465	rho	248010000
20570500 "il mass"	sum	1.000000	2500.0	1	20570904	0.04423125	rho	252010000
20570501 0.0	1.0	cntrlvar	700	20570905		0.0145264	rho	790010000
20570502	1.0	cntrlvar	701	*				
20570503	1.0	cntrlvar	702	20571000 "bl mass"	sum	1.000000	2500.0	1
20570504	1.0	cntrlvar	703	20571001	0.0	1.0	cntrlvar	706
20570505	1.0	cntrlvar	704	20571002		1.0	cntrlvar	707
*				20571003		1.0	cntrlvar	708
*****				20571004		1.0	cntrlvar	709
* calculate broken primary loop mass				*				
*****				*****				
*				* pressure vessel mass				
20570600 "bhl mass"	sum	1.000000	2848.8553	1	*****			
20570601 0.0	0.04463902	rho	200010000	*				
20570602	0.00093545	rho	202010000	20571100 "pvd mass"	sum	1.000000	2500.0	1
20570603	0.00058598	rho	204010000	20571101	0.0	0.136090	rho	100010000
20570604	0.04446715	rho	206010000	20571102		0.054250	rho	104010000
20570605	0.02373491	rho	208010000	20571103		0.06604292	rho	108010000
20570606	0.01778686	rho	20820000	20571104		0.08474058	rho	108020000
20570607	0.1250	rho	212010000	20571105		0.0596214	rho	108030000
20570608	0.2323	rho	216010000	20571106		0.0596214	rho	108040000
*				20571107		0.0596214	rho	108050000
20570700 "bsg mass"	sum	1.000000	2500.0	1	20571108	0.0596214	rho	108060000

20571109	0.0596214	rho	108070000	20575001	0.0	1.0	p	416010000
20571110	0.0596214	rho	108080000	20575002		-1.0	p	420040000
20571111	0.123035	rho	108090000	*				
*				20575100 "dp060d"		sum	1.00000	80000. 1
20571200 "pvlp mass"	sum	1.000000	2500.0 1	20575101	0.0	1.0	p	424010000
20571201 0.0	0.1661	rho	112010000	20575102		-1.0	p	420050000
20571202	0.0943	rho	116010000	*				
*				20575200 "dpe070"		sum	1.00000	45000. 1
20571300 "pvc mass"	sum	1.000000	2500.0 1	20575201	0.0	1.0	p	424010000
20571301 0.0	0.1821	rho	120010000	20575202		-1.0	p	436010000
20571302	0.07312	rho	124010000	*				
20571303	0.07312	rho	124020000	20575300 "dpe080"		sum	1.00000	266000. 1
20571304	0.07312	rho	124030000	20575301	0.0	1.0	p	436010000
20571305	0.07312	rho	124040000	20575302		-1.0	p	440010000
20571306	0.07312	rho	124050000	*				
20571307	0.07312	rho	124060000	20575400 "dp190d"		sum	1.00000	80000. 1
20571308	0.15220	rho	128010000	20575401	0.0	1.0	p	216010000
20571309	0.10600	rho	132010000	20575402		-1.0	p	220040000
20571310	0.09389	rho	136010000	*				
20571311	0.04450	rho	140010000	20575500 "dp200d"		sum	1.00000	80000. 1
20571312	0.06209	rho	156010000	20575501	0.0	1.0	p	224010000
20571313	0.06288	rho	156020000	20575502		-1.0	p	220050000
*				*				
20571400 "pvup mass"	sum	1.000000	2500.0 1	20575600 "dpe210"		sum	1.00000	45000. 1
20571401 0.0	0.1655	rho	144010000	20575601	0.0	1.0	p	224010000
20571402	0.1970	rho	148010000	20575602		-1.0	p	236010000
20571403	0.1475	rho	152010000	*				
*				20575700 "dpe220"		sum	1.00000	266000. 1
20571500 "pv mass"	sum	1.000000	2500.0 1	20575701	0.0	1.0	p	236010000
20571501 0.0	1.0	cntrivar	711	20575702		-1.0	p	240010000
20571502	1.0	cntrivar	712	*				
20571503	1.0	cntrivar	713	20576100 "dpe300"		sum	1.00000	32000. 1
20571504	1.0	cntrivar	714	20576101	0.0	1.0	p	124010000
*				20576102		-1.0	p	128010000
*****				*				
* primary mass				*****				
*****				* control steam valve to give sg pressure of 7.10 mpa.				
*				*****				
20572000 "pv mass"	sum	1.000000	2500.0 1	*				
20572001 0.0	1.0	cntrivar	705	20580300 "pres err"		sum	100.000-9	-5.3342-6 1
20572002	1.0	cntrivar	710	-		3	-05	05
20572003	1.0	cntrivar	715	20580301	-6.90e6	1.0 p		316010000
*				*				
*****				20580400 "del area"		mult	1.0000000	-1.0668-6 1
* differential pressure calculations				20580401	cntrivar 1	cntrivar	803	
*****				*				
*				20580500 "vlv area"		sum	1.0000000	.2300 1
20575000 "dp050d"	sum	1.00000	80000. 1	-		3	0.0	1.0000000

```

20580501 0.0 1.0 cntrlvar 805
*
*****
* calculate wide range sg liquid levels
*****
*
20531200 "blsglwde" sum 1.0000000 8.9221049 1
20531201 0.0 2.5464 voidf 304010000
20531202 2.5654 voidf 304020000
20531203 2.5654 voidf 304030000
20531204 2.0980 voidf 304040000
20531205 2.0223 voidf 304050000
20531206 2.1200 voidf 308010000
20531207 3.7778 voidf 316010000
*
20551200 "ilsglwde" sum 1.0000000 8.8904978 1
20551201 0.0 2.5464 voidf 504010000
20551202 2.5654 voidf 504020000
20551203 2.5654 voidf 504030000
20551204 2.0980 voidf 504040000
20551205 2.0223 voidf 504050000
20551206 2.1200 voidf 508010000
20551207 3.7778 voidf 516010000
*
*****
* set rcv speed to control to loop flow of 24.2 kg/s
*****
*
20523800 "spd err" sum 2.0000000 158.365-6 1
*
3 -5.000000 5.0000000
20523801 34.65 -1.0 mflowj 240010000
*
20523900 "delspeed" mult 1.0000000 31.6731-6 1
20523901 cntrlvar 1 cntrlvar 238
*
20524000 "rcpspeed" sum 1.0000000 89.403724 1
20524001 0.0 1.0 cntrlvar 239
20524002 1.0 cntrlvar 240
*
*****
* set hot leg bypass valve areas to 0.0
*****
*
20520300 "blhtlbyp" constant 0.0985
*
20540300 "ilhtlbyp" constant 0.0985
*
*****

```

```

* calculate net flow to secondary
*****
*
20585000 "netsecl" sum 1.0000000 0 1
20585001 0.0 1. mflowj 361000000
20585002 1. mflowj 351000000
20585003 1. mflowj 561000000
20585004 1. mflowj 551000000
20585005 -1. mflowj 805000000
20585006 -1. mflowj 803000000
20585007 -1. mflowj 369000000
20585008 -1. mflowj 379000000
20585009 -1. mflowj 569000000
20585010 -1. mflowj 579000000
*
*****
* calculate the overall pressure vessel liquid level
*****
*
20512800 "uh level" sum 1.000000 10.657100 1
20512801 0.0 0.626 voidf 112010000
20512802 0.4762 voidf 116010000
20512803 1.2588 voidf 120010000
20512804 0.610 voidf 124010000
20512805 0.610 voidf 124020000
20512806 0.610 voidf 124030000
20512807 0.610 voidf 124040000
20512808 0.610 voidf 124050000
20512809 0.610 voidf 124060000
20512810 0.867 voidf 128010000
20512811 0.6757 voidf 132010000
20512812 0.600 voidf 136010000
20512813 0.3674 voidf 140010000
20512814 0.897 voidf 144010000
20512815 0.725 voidf 148010000
20512816 0.504 voidf 152010000
*
*****
* calculate the steam generator liquid level
*****
*
20551600 "sga lvl" sum 1.000000 17.695300 1
20551601 0.0 2.5464 voidf 504010000
20551602 2.5654 voidf 504020000
20551603 2.5654 voidf 504030000
20551604 2.0980 voidf 504040000
20551605 2.0223 voidf 504050000
20551606 2.120 voidf 508010000

```

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Appendix B

Input Deck for SGTR Transient Calculation

```

*****
*
* lstr sgtr transient input deck with relap5/mod3.1
*
*****
*
0000100  restart  transnt
*
0000101  run
0000102  si si
0000103  4265
*
* time step control
*
0000201  3000.0  1.0-6  0.5  3  10  1000  1000
0000202  5000.0  1.0-6  0.1  3  50  5000  5000
*
20800001  dt      0.0
20800002  dtcmt   0.0
*
*****
* minor edits
*****
*
301 p      610010000  *pzt pressure
302 p      516010000  *sg-b steam pressure
303 p      316010000  *sg-i steam pressure
304 mflowj 208010000  *loop-i hot leg flow
305 mflowj 408010000  *loop-b hot leg flow
306 mflowj 248010000  *loop-i cold leg flow
307 mflowj 452010000  *loop-b cold leg flow
308 mflowj 108010000  *core bypass flow
309 mflowj 120010000  *core inlet flow
310 tempf  104010000  *vessel inlet temp
311 tempf  136010000  *vessel outlet temp
312 tempf  120010000  *core inlet temp
313 tempf  128010000  *core outlet temp
314 tempf  316010000  *sg-i steam temp
315 tempf  516010000  *sg-b steam temp
316 tempf  200010000  *loop-i hot leg temp
317 tempf  400010000  *loop-b hot leg temp
318 tempf  124010000  *core fluid temp-1
319 tempf  124020000  *core fluid temp-2
320 tempf  124030000  *core fluid temp-3
321 tempf  124040000  *core fluid temp-4
322 tempf  124050000  *core fluid temp-5
323 tempf  124060000  *core fluid temp-6
324 sattemp 243010000  *hot leg sat. temp

```

```

325 sattemp 208010000  *cold leg sat. temp
326 voidg   152010000  *upper head voidf
327 pmpvel   240
328 pmphead   240
329 pmpvel   440
330 pmphead   440
331 cntrlvar 512      *sg-b wr level
332 cntrlvar 508      *sg-b nr level
333 cntrlvar 504      *sg-b boiling water level
334 cntrlvar 312      *sg-i wr level
335 cntrlvar 308      *sg-i nr level
336 cntrlvar 304      *sg-i boiling water level
337 cntrlvar 610      *pzt level
338 cntrlvar 720      *primary mass
339 cntrlvar 309      *sg-i mass
340 cntrlvar 509      *sg-b mass
341 cntrlvar 888      *rx power
342 cputime   0        *cpu time
343 cntrlvar 916      *break flowrate
344 cntrlvar 915      *integrated break flow
345 cntrlvar 917      *total feedwater to sg-a
346 cntrlvar 918      *total feedwater to sg-b
347 mflowj   391000000 *sg-a steam dump
348 mflowj   612000000 *pzt aux spray
349 mflowj   351000000 *aux feed a (hot)
350 mflowj   353000000 *aux feed a (cold)
351 mflowj   551000000 *aux feed b (hot)
352 cntrlvar 919      *aux feed a (total)
353 mflowj   771000000 *hpsi to cl-i
354 mflowj   721000000 *hpsi to cl-b
355 mflowj   722000000 *hpsi to up
356 tempf    152010000 *up head temp
357 tempf    108040000 *mid downcomer temp
358 cntrlvar 921      *total water inject
359 cntrlvar 922      *HPSI-CL total flow
*
*****
* variable trips
*****
*
0000501 p      610010000  lt  null 0 1.342e+7 1 *rx trip signal
0000502 time      0  ge  null 0 1.e6 1 *power
0000505 p      610010000  lt  null 0 1.287e+7 1 *rcp&si
0000506 time      0  ge  timeof 505 17.0 1 *lpsi delay
0000507 cntrlvar 610  le  null 0 1.0 n *hpsi termi.
0000508 time      0  le  timeof 505 2900.0 n *hpsi termi.
0000510 time      0  ge  timeof 505 98.0 n *il hpi
0000511 time      0  ge  timeof 505 300.0 n *il hppi to up

```

0000512	time	0	ge	timeof	505	98.0	n *bl hpi	0000601	-603	and	571	n * bl sec relief valve
0000514	cntrlvar	30	ge	cntrlvar	31	0.0	n *mean temp	0000602	603	and	570	n
0000516	cntrlvar	30	lt	cntrlvar	31	0.0	n	0000603	601	or	602	n
0000520	p	610010000	ge	null	0	1.646e+7	l *high pres	0000604	-606	and	575	n * bl sec safety valve
0000522	p	610010000	ge	null	0	1.726e+7	n *pzz sfty	0000605	606	and	574	n
0000524	p	610010000	ge	null	0	1.568e+7	n *pzz spry	0000606	604	or	605	n
0000525	time	0	ge	timeof	501	2666.0	l *pzz aux spray	0000607	-609	and	561	n * il sec relief valve
0000526	p	610010000	gt	null	0	1.607e+7	n * porv	0000608	609	and	560	n
0000527	p	516010000	gt	p	610010000	0.0	l *aux spray term	0000609	607	or	608	n
0000528	p	610010000	gt	null	0	1.620e+7	n	0000610	-612	and	565	n * il sec safety valve
0000529	time	0	ge	null	0	0.0	l *pzz prp. hrs	0000611	612	and	564	n
0000530	p	610010000	lt	null	0	1.540e+7	n *pzz bkup hrs	0000612	610	or	611	n
0000531	p	610010000	lt	null	0	1.534e+7	n	0000613	-615	and	528	n * porv
0000532	cntrlvar	610	lt	null	0	0.25656	n *lo nrm pr lvi	0000614	615	and	526	n
0000535	time	0	ge	null	0	0.0	l *tube break	0000615	613	or	614	n
0000536	time	0	ge	null	0	0.0	l *bl flow	0000616	510	and	507	n * hpsi to il cl
0000537	time	0	lt	null	0	0.0	l *valve	0000617	511	and	508	n * hpsi to core up
0000538	time	0	lt	null	0	0.0	l *il flow	0000618	512	and	507	n * hpsi to il
0000539	time	0	lt	null	0	0.0	l *valve	0000619	525	and	-527	n * aux spray
*0000540	time	0	le	null	0	10000.0	n	0000620	580	or	581	l * reactor trip
0000550	p	610010000	ge	null	0	1.297e+7	n *main feed	0000621	520	or	620	l
0000552	time	0	ge	timeof	505	37.0	n *aux feed	0000622	621	or	501	l
0000553	time	0	le	timeof	552	200.0	n *aux feed	0000623	552	and	553	n * sg aux feed, il
0000554	cntrlvar	312	lt	null	0	12.85	n *aux feed	0000624	552	and	556	n * , bl
0000555	time	0	gt	timeof	505	237.0	n *aux feed a cold	0000625	-586	or	-586	n * steam sink pressure
0000556	time	0	le	timeof	552	81.0	n *aux feed	0000626	579	or	568	l * hpi *
0000557	tempf	206010000	ge	null	0	531.4	n * termi. of stdump	0000627	626	or	505	l
0000560	p	316010000	gt	null	0	6.4e+6	n *il sg rel	0000630	-632	and	531	n * pzz backup heater cntl
0000561	p	316010000	gt	null	0	7.3e+6	n	0000631	632	and	530	n
0000564	p	316010000	gt	null	0	7.69e+6	n *il sg saf	0000632	630	or	631	n
0000565	p	316010000	gt	null	0	8.68e+6	n	0000633	-505	and	-532	n * pzz hrs off on sis or low pzz lvl
0000568	p	316010000	le	null	0	0.0	l *il msiv	0000634	632	and	633	n * pzz hrs off on low pzz level
0000569	p	316010000	lt	null	0	4.235e+6	l	0000635	-568	and	-568	n 0
0000570	p	516010000	gt	null	0	6.4e+6	n *bl sg rel	0000636	-578	and	-578	n 0
0000571	p	516010000	gt	null	0	7.3e+6	n	0000637	555	and	554	n
0000574	p	516010000	gt	null	0	7.69e+6	n *bl sg saf	0000638	578	and	557	n * intact loop RV manual open
0000575	p	516010000	gt	null	0	8.68e+6	n	0000700	-535	and	-535	n 0 *break close
0000578	time	0	ge	timeof	501	722.0	l *bl msiv	*				
0000579	p	516010000	lt	null	0	4.235e+6	l					
0000580	cntrlvar	308	lt	null	0	0.25	l *low sg lev					
0000581	cntrlvar	508	lt	null	0	0.25	l					
0000583	time	0	ge	null	0	0.0	n *stm hdr vlv					
0000585	time	0	lt	null	0	0.0	n *stm thrtl	2400000	nprcpump	pump		
0000586	time	0	ge	null	0	11.0	n * valve	2400101	0.0	0.802	0.0235	0.0 90.0 0.351 0
0000599	time	0	lt	null	0	1000.0	n * ss pres	2400108	236010000	0.0222	0.0	0.0 0000
								2400109	244000000	0.0337	0.0525	0.0525 0000
								2400200	003	15471507.	560.76	
								2400201	0	2.0813	2.2480	0.0

* logical trips												

2400202	0	1.3711	1.3711	0.0
2400301	0	0	0	-1 0 505 0
2400302	188.50000	680636	05400000	10.000000 55.200000
2400303	0.54	750.0	0.0	0.0 0.0 0.0 0.0

 * single phase head and torque data from 1stf sys. description

2401100	1	1	0.00	1.36	0.10	1.38	0.24	1.42	0.40	1.41
2401101			0.60	1.32	0.80	1.19	1.00	1.00		
2401200	1	2	0.00	-0.97	0.20	-0.68	0.50	-0.20	0.65	0.07
2401201			0.80	0.40	1.00	1.00				
2401300	1	3	-1.0	3.20	-0.90	2.80	-0.80	2.46	-0.60	1.94
2401301			-0.40	1.57	-0.20	1.41	0.00	1.36		
2401400	1	4	-1.00	3.20	-0.80	2.76	-0.60	2.41	-0.40	2.09
2401401			-0.20	1.81	0.00	1.58				
2401500	1	5	0.00	0.00	1.00	0.00				
2401600	1	6	0.00	0.00	1.00	0.00				
2401700	1	7	-1.00	0.00	0.00	0.00				
2401800	1	8	-1.00	0.00	0.00	0.00				

* torque data

2401900	2	1	0.00	0.36	0.12	0.38	0.20	0.44	0.30	0.58
2401901			0.50	0.73	0.70	0.81	1.00	1.00		
2402000	2	2	0.00	-1.26	0.10	-0.88	0.30	-0.31	0.50	0.09
2402001			0.65	0.30	0.86	0.63	1.00	1.00		
2402100	2	3	-1.00	2.40	-0.85	1.70	-0.65	1.12	-0.50	0.84
2402101			-0.40	0.69	-0.20	0.59	0.00	0.36		
2402200	2	4	-1.00	2.40	-0.80	2.12	-0.60	1.80	-0.30	1.32
2402201			0.00	0.80						
2402300	2	5	0.00	0.00	1.00	0.00				
2402400	2	6	0.00	0.00	1.00	0.00				
2402500	2	7	-1.00	0.00	0.00	0.00				
2402600	2	8	-1.00	0.00	0.00	0.00				

* two phase multiplier tables for head of rc pump 240

2403000	0	0.0	0.0
2403001		0.10	0.0
2403002		0.15	0.05
2403003		0.24	0.80
2403004		0.30	0.96
2403005		0.40	0.98
2403006		0.60	0.97
2403007		0.80	0.90
2403008		0.90	0.80

2403009	0.96	0.50
2403010	1.00	0.0

* two phase multiplier tables for torque of rc pump 240

2403100	0	0.0	0.0
2403101		1.0	0.0

* two-phase diff curves from r5 built-in data

* head difference curves

2404100	1	1	0.00	0.00	0.10	0.83	0.20	1.09	0.50	1.02
2404101			0.70	1.01	0.90	0.94	1.00	1.00		
2404200	1	2	0.00	0.00	0.10	-0.40	0.20	0.00	0.30	0.10
2404201			0.40	0.21	0.80	0.67	0.90	0.80	1.00	1.00
2404300	1	3	-1.00	-1.16	-0.90	-1.24	-0.80	-1.77	-0.70	-2.36
2404301			-0.60	-2.79	-0.50	-2.91	-0.40	-2.67	-0.25	-1.69
2404302			-0.10	-0.50	0.00	0.00				
2404400	1	4	-1.00	-1.16	-0.90	-0.78	-0.80	-0.50	-0.70	-0.31
2404401			-0.00	-0.17	-0.50	-0.08	-0.35	0.00	-0.20	0.05
2404402			-0.10	0.08	0.00	0.11				
2404500	1	5	0.00	0.00	1.00	0.00				
2404600	1	6	0.00	0.00	1.00	0.00				
2404700	1	7	-1.00	0.00	0.00	0.00				
2404800	1	8	-1.00	0.00	0.00	0.00				

* torque difference curves

2404900	2	1	0.0	0.0	0.0	0.0
2405000	2	2	0.0	0.0	0.0	0.0
2405100	2	3	0.0	0.0	0.0	0.0
2405200	2	4	0.0	0.0	0.0	0.0
2405300	2	5	0.0	0.0	0.0	0.0
2405400	2	6	0.0	0.0	0.0	0.0
2405500	2	7	0.0	0.0	0.0	0.0
2405600	2	8	0.0	0.0	0.0	0.0

* pump coastdown data

2406100	501		* norm speed
2406101	0.0	128.3	* 160.22
2406102	80.0	128.3	* 160.22
2406103	83.0	122.0	* 153.75
2406104	86.0	118.9	* 149.87
2406105	89.0	114.9	* 144.86
2406106	101.0	96.7	* 121.90
2406107	110.0	82.6	* 104.12
2406108	119.0	74.4	* 93.77

2406109	131.0	63.4	* 79.86
2406110	140.0	56.7	* 71.46
2406111	149.0	51.8	* 65.31
2406112	161.0	46.3	* 58.36
2406113	170.0	41.7	* 52.54
2406114	179.0	38.2	* 48.18
2406115	191.0	34.8	* 43.81
2406116	200.0	32.3	* 40.74
2406117	209.0	30.0	* 37.38
2406118	221.0	27.3	* 34.43
2406119	230.0	25.3	* 31.85
2406120	239.0	23.2	* 29.26
2406121	251.0	21.4	* 27.00
2406122	260.0	20.3	* 25.54
2406123	269.0	19.0	* 23.92
2406124	281.0	16.3	* 20.53
2406125	290.0	14.6	* 18.43
2406126	299.0	12.4	* 15.60
2406127	320.0	9.9	* 12.48
2406128	341.0	7.4	* 9.36
2406129	359.0	5.0	* 6.24
2406130	380.0	2.5	* 3.12
2406131	400.0	0.0	
2406132	1000.0	0.0	
2406133	3960.0	0.0	*il rcp restart
2406134	3970.0	50.0	
2406135	3980.0	90.0	
2406136	3990.0	128.3	
2406137	5000.0	128.3	

*

3290000	ilmsiv	valve							
3290101	328010000	332000000	0.00429	0.0	0.0	0.0	0.0	0.0	0.0
3290201	0	12.637699	17.284590	0.0					* 2.7477202
3290300	mtrvrv								
3290301	635	568	2.0000000	1.0000000	0				

*

3500000	auxfed	tmdpvcl							
3500101	8.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3500200	3								
3500201	0.0	5.95300e+6		495.2					

*

3510000	auxfed	tmdpjvn							
3510101	350000000	300000000	0.004						
3510200	1	623							
3510201	0.0	0.0	0.0	0.0					

3510202	0.01	1.500	0.0	0.0					
3510203	5000.0	1.500	0.0	0.0					

*

3520000	auxfed	tmdpvcl							
3520101	8.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3520200	3								
3520201	0.0	5.95300e+6		300.2					

*

3530000	auxfed	tmdpjvn							
3530101	352000000	300000000	0.004						
3530200	1	637							
3530201	0.0	0.0	0.0	0.0					
3530202	0.01	0.500	0.0	0.0					
3530203	500.0	0.500	0.0	0.0					
3530204	500.1	1.0	0.0	0.0					
3530205	5000.0	1.0	0.0	0.0					

*

3600000	npstegfw	tmdpvcl							
3600101	0.139	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3600200	3								
3600201	0.0	5.83400e+6		495.35					

*

3610000	npstegfw	tmdpjvn							
3610101	360000000	300000000	4.00e-3						
3610200	1	550	cntrlvar	361					
3610201	-1.0e75	0.0	0.0	0.0					
3610202	0.0	0.0	0.0	0.0					
3610203	5.0	5.0	0.0	0.0					
3610204	7.0	7.0	0.0	0.0					
3610205	1000.0	7.0	0.0	0.0					

*

* secondary relief and safety valves, intact loop

3690000	blsgrv	valve							
3690101	320010000	370000000	2.96e-4	0.0149	0.0	0.0	0.0	0.0	0.0
3690201	0	0.0	0.0	0.0					* 0.0
3690300	trpvlv								
3690301	638								

*

3700000	contain	tmdpvcl							
3700101	1.0e+8	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

```

3700200 3
3700201 0.0 1.01325e+5 293.15
*
*****
3790000 blsgsv valve
3790101 324010000 380000000 0.00195 0.00055 0.0 0100
3790201 0 0.0 0.0 0.0 * 0.0
3790300 trpvlv
3790301 612
*
*****
3800000 contain tmdpvov
3800101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 0.0 00
3800200 3
3800201 0.0 1.01325e+5 293.15
*
*****
*
4160000 wpsgfb branch
4160001 3 0
4160101 0 1.1035 0.2323 0.0 90.0 1.1035 4.57e-5
4160102 0.4474 00
4160200 003 15460476 586.5
4162101 412010000 416000000 0.2093 0.0 0.0 0000
4163101 416010000 420000000 0.04254 0.0 0.0 0000
4164101 416010000 417000000 5.0e-4 0.0 0.0 0100
4162201 1.247 1.247 0.0
4163201 1.247 1.247 0.0
4164201 0.1 0.1 0.0
*
*****
*
4170000 bktln1 snglvov
4170101 5.0e-4 1.18 0.0 0.0 0.0 0.0 4.57e-5 0.0 00
4170200 003 15453426 560.5
*
4180000 bktln4 branch
4180001 2 0
4180101 5.0e-4 2.06 0.0 0.0 -90.0 -2.06 4.57e-5 0.0 00
4180200 003 15441269 586.5
4181101 417010000 418000000 5.0e-4 0.0 0.0 0000
4182101 418010000 419000000 5.0e-4 0.0 0.0 0000
4181201 0.1 0.1 0.0
4182201 0.1 0.1 0.0
*
4190000 bktln5 snglvov
4190101 5.0e-4 1.9 0.0 0.0 0.0 0.0 4.57e-5 0.0 00
4190200 003 15433426 560.5

```

```

*
4930000 break valve
4930101 419010000 494000000 5.0e-4 0.0 0.0 0000
4930201 1 0.0 0.0 0.0
4930300 trpvlv
4930301 535
*
*****
*
4940000 bktln5 snglvov
4940101 5.0e-4 0.24 0.0 0.0 0.0 0.0 4.57e-5 0.0 00
4940200 003 7310426 540.5
*
4950000 bktln4 branch
4950001 2 0
4950101 5.0e-4 0.35 0.0 0.0 90.0 0.35 4.57e-6 0.0 00
4950200 003 7311269 546.5
4951101 495010000 496000000 3.02e-5 0.0 0.0 0100
4952101 494010000 495000000 5.0e-4 0.0 0.0 0000
4951201 0.1 0.1 0.0
4952201 0.1 0.1 0.0
*
4960000 brknoz1 pipe
4960001 3
4960101 3.02e-5 3
4960301 0.6 3
4960401 0.0 3
4960601 90.0 3
4960701 0.6 3
4960801 1.2e-6 0.0062 3
4960901 0.0 0.0 2
4961001 00 3
4961101 01000 2
4961201 003 15315536 586.50 0.0 0.0 1
4961301 003 11325536 569.50 0.0 0.0 2
4961401 003 7330536 552.50 0.0 0.0 3
4961500 0
4961601 0.1 0.1 0.0 1
4961701 0.1 0.1 0.0 2
*
4960000 brknoz1 pipe
4960001 12
4960101 3.02e-5 12
4960301 0.15 12
4960401 0.0 12
4960601 90.0 12
4960701 0.15 12
4960801 1.2e-6 0.0062 12

```

```

*4960901  0.0      0.0    11
*4961001  00      12
*4961101  01000    11
*4961201  003      15315536. 586.50 0.0 0.0 1
*4961202  003      14625536. 583.50 0.0 0.0 2
*4961203  003      13930536. 580.50 0.0 0.0 3
*4961204  003      13295536. 577.50 0.0 0.0 4
*4961205  003      12625536. 574.50 0.0 0.0 5
*4961206  003      11930536. 571.50 0.0 0.0 6
*4961207  003      11215536. 568.50 0.0 0.0 7
*4961208  003      10625536. 565.50 0.0 0.0 8
*4961209  003      9949276. 562.50 0.0 0.0 9
*4961210  003      9278626. 559.50 0.0 0.0 10
*4961211  003      7935536. 556.50 0.0 0.0 11
*4961212  003      7330536. 552.50 0.0 0.0 12
*4961300  0
*4961301  0.1 0.1 0.0 1
*4961302  0.1 0.1 0.0 2
*4961303  0.1 0.1 0.0 3
*4961304  0.1 0.1 0.0 4
*4961305  0.1 0.1 0.0 5
*4961306  0.1 0.1 0.0 6
*4961307  0.1 0.1 0.0 7
*4961308  0.1 0.1 0.0 8
*4961309  0.1 0.1 0.0 9
*4961310  0.1 0.1 0.0 10
*4961311  0.1 0.1 0.0 11
*
4970000  bkln2  branch
4970001  2      0
4970101  5.0e-4  0.75 0.0 0.0 90.0 0.75 4.57e-6 0.0 0.0
4970200  003      7331269. 546.5
4971101  496010000 497000000 3.02e-5 0.0 0.0 0100
4972101  497010000 498000000 5.0e-4 0.0 0.0 0000
4971201  0.1 0.1 0.0
4972201  0.1 0.1 0.0
*
4980000  bkln2  pipe
4980001  2
4980101  5.0e-4  2
4980301  1.25  2
4980601  0.0  2
4980701  0.0  2
4980801  4.57e-5 0.0  2
4980901  0.0 0.0  1
4981001  00  2
4981101  0000  1
4981201  003      7344729. 540.5 0.0 0.0 1

```

```

4981202  003      7350523. 540.5 0.0 0.0 2
4981300  0
4981301  0.1 0.1 0.0 1
*
4990000  bkln1  sngljun
4990101  498010000 504010003 5.0e-4 0.0 0.0 0100
4990201  0      0.1 0.1 0.0
*

```

```

*
4400000  wprcpump  pump
4400101  0.0 0.802 0.0235 0.0 90.0 0.351 0.0
4400108  436010000 0.0222 0.0 0.0 0000
4400109  444000000 0.0337 0.0525 0.0525 0000
4400200  003      15471901. 560.6
4400201  0      2.0050 2.1683 0.0
4400202  0      1.3208 1.3208 0.0
4400301  240 240 240 -1 0 505 0
4400302  188.50000 .65942 .05400000 10.000000 55.200000
4400303  0.54 750.0 0.0 0.0 0.0 0.0 0.0
*

```

* pump coastdown data

```

*
4406100  501      * norm speed
4406101  0.0 124.3 * 160.22
4406102  80.0 124.3 * 160.22
4406103  83.0 118.2 * 153.75
4406104  86.0 115.2 * 149.87
4406105  89.0 111.4 * 144.86
4406106  101.0 93.7 * 121.90
4406107  110.0 80.1 * 104.12
4406108  119.0 72.1 * 93.77
4406109  131.0 61.4 * 79.86
4406110  140.0 54.9 * 71.46
4406111  149.0 50.2 * 65.31
4406112  161.0 44.9 * 58.36
4406113  170.0 40.4 * 52.54
4406114  179.0 37.0 * 48.18
4406115  191.0 33.7 * 43.81
4406116  200.0 31.3 * 40.74
4406117  209.0 29.1 * 37.38
4406118  221.0 26.5 * 34.43
4406119  230.0 24.5 * 31.85
4406120  239.0 22.5 * 29.26
4406121  251.0 20.8 * 27.00
4406122  260.0 19.6 * 25.54
4406123  269.0 18.4 * 23.92
4406124  281.0 15.8 * 20.53

```

4406125	290.0	14.2	* 18.43
4406126	299.0	12.0	* 15.60
4406127	320.0	9.6	* 12.48
4406128	341.0	7.2	* 9.36
4406129	359.0	4.8	* 6.24
4406130	380.0	2.4	* 3.12
4406131	400.0	0.0	
4406132	1000.0	0.0	

*

```
*****
5290000  ilmsiv  valve
5290101  528010000  532000000  0.00429  0.0  0.0  0100
5290201  0          5.7878014  17.263954  0.0          * 2.7467386
5290300  mtrvrv
5290301  636        578          2.0000000  1.0000000  0
*
```

*

```
*****
5500000  auxfed  tmdpvov
5500101  0.0      5.0  0.0  0.0  0.0  0.0  0.0  0  00
5500200  3
5500201  0.0      5.95300e+6  495.2
*
```

*

```
*****
5510000  auxfed  tmdpvun
5510101  550000000  500000000  0.004
5510200  1  624
5510201  0.0  0.0  0.0  0.0
5510202  0.01  1.140  0.0  0.0
5510203  5000.0  1.140  0.0  0.0
*
```

*

```
*****
5610000  wpstegfw  tmdpvun
5610101  560000000  500000000  4.00e-3
5610200  1  550  cntrivar  561
5610201  -1.0e75  0.0  0.0  0.0
5610202  0.0  0.0  0.0  0.0
5610203  5.0  5.0  0.0  0.0
5610204  7.0  7.0  0.0  0.0
5610205  1000.0  7.0  0.0  0.0
*
```

*

```
*****
* pzt aux spray
*****
```

*

```
*****
6110000  auxtank  tmdpvov
6110101  1.0e+5  10.0  0.0  0.0  0.0  0.0  00
6110200  3
6110201  0.0  16.0e+6  310.0
*
```

*

*

```
6120000  auxjun  tmdpvun
6120101  611000000  610010001  2.552e-3
6120200  1  619
6120201  -1.0  0.0  0.0  0.0
6120202  0.0  0.1  0.0  0.0
6120203  10.0  0.1  0.0  0.0
6120204  700.0  0.1  0.0  0.0
6120205  1000.0  0.1  0.0  0.0
*
```

*

```
*****
* eccs
*****
7200000  ilsi  tmdpvov
7200101  4.375  10.0  0.0  0.0  0.0  0.0  0.0  00
7200200  3
7200201  0.0  1.013e-5  310.00
*
```

*

```
*****
* high pressure safety injection to cold leg
*****
```

*

```
*****
7210000  ilsi  tmdpvun
7210101  720000000  740000000  2.552e-3
7210200  1  616  p  448010000
7210201  -1.0  0.0  0.0  0.0
7210202  0.0  0.0  0.0  0.0
7210203  0.0  0.629  0.0  0.0
7210204  5.88e6  0.629  0.0  0.0
7210205  6.08e6  0.6065  0.0  0.0
7210206  6.28e6  0.5875  0.0  0.0
7210207  6.47e6  0.569  0.0  0.0
7210208  6.67e6  0.554  0.0  0.0
7210209  6.86e6  0.535  0.0  0.0
7210210  7.06e6  0.5125  0.0  0.0
7210211  7.26e6  0.4975  0.0  0.0
7210212  7.45e6  0.475  0.0  0.0
7210213  7.65e6  0.4565  0.0  0.0
7210214  7.85e6  0.434  0.0  0.0
7210215  8.04e6  0.4115  0.0  0.0
7210216  8.24e6  0.385  0.0  0.0
7210217  8.43e6  0.3625  0.0  0.0
7210218  8.63e6  0.340  0.0  0.0
7210219  8.83e6  0.314  0.0  0.0
7210220  9.02e6  0.2875  0.0  0.0
7210221  9.22e6  0.254  0.0  0.0
7210222  9.41e6  0.224  0.0  0.0
*
```

*

```

7210223    9.61e6    0.190    0.0    0.0
7210224    9.81e6    0.1375    0.0    0.0
7210225    10.0e6    0.059    0.0    0.0
7210226    10.15e6    0.0    0.0    0.0
*
7500000    iisi      tmdpv0l
7500101    4.375      10.0 0.0    0.0    0.0    0.0    0.0    0.0
7500200    3
7500201    0.0        1.013e+5    310.00
*
7220000    ilsi      tmdpj0n
7220101    750000000    140000000    2.552e-3
7220200    1 617 p 140010000
7220201    -1.0        0.0    0.0    0.0
7220202    0.0        0.0    0.0    0.0
7220203    0.0        1.388    0.0    0.0
7220204    5.88e6      1.388    0.0    0.0
7220205    6.08e6      1.343    0.0    0.0
7220206    6.28e6      1.305    0.0    0.0
7220207    6.47e6      1.268    0.0    0.0
7220208    6.67e6      1.238    0.0    0.0
7220209    6.86e6      1.200    0.0    0.0
7220210    7.06e6      1.155    0.0    0.0
7220211    7.26e6      1.125    0.0    0.0
7220212    7.45e6      1.080    0.0    0.0
7220213    7.65e6      1.043    0.0    0.0
7220214    7.85e6      0.998    0.0    0.0
7220215    8.04e6      0.953    0.0    0.0
7220216    8.24e6      0.900    0.0    0.0
7220217    8.43e6      0.855    0.0    0.0
7220218    8.63e6      0.810    0.0    0.0
7220219    8.83e6      0.758    0.0    0.0
7220220    9.02e6      0.705    0.0    0.0
7220221    9.22e6      0.638    0.0    0.0
7220222    9.41e6      0.578    0.0    0.0
7220223    9.61e6      0.510    0.0    0.0
7220224    9.81e6      0.405    0.0    0.0
7220225    10.0e6      0.248    0.0    0.0
7220226    10.15e6     0.0    0.0    0.0
*
*****
7300000    ilchrg    tmdpv0l
7300101    4.375      10.0 0.0    0.0    0.0    0.0    0.0    0.0
7300200    3
7300201    0.0        1.013e+5    310.00
*
*****
7310000    ilchrg    tmdpj0n

```

```

7310101    730000000    740000000    2.552e-3
7310200    1 510 p 44010000
7310201    -1.0        0.0    0.0    0.0
7310202    0.0        0.0    0.0    0.0
7310203    0.0        0.13    0.0    0.0
7310204    15.0e6     0.13    0.0    0.0
*
*****
7400000    iieccsln    snglv0l
7400101    2.552e-3    16.0 0.0    0.0    0.0    0.0    3.333e-5
7400102    0.0 00
7400200    0          15598371. 83230.665 2445532.2 0.0
*
*****
7700000    blsi      tmdpv0l
7700101    4.375      10.0 0.0    0.0    0.0    0.0    0.0    0.0
7700200    3
7700201    0.0        1.013e+5    310.0
*
*****
*
7710000    blsi      tmdpj0n
7710101    770000000    790000000    2.552e-3
7710200    1 618 p 248010000
7710201    -1.0        0.0    0.0    0.0
7710202    0.0        0.0    0.0    0.0
7710203    0.0        0.629    0.0    0.0
7710204    5.88e6      0.629    0.0    0.0
7710205    6.08e6      0.6065    0.0    0.0
7710206    6.28e6      0.5875    0.0    0.0
7710207    6.47e6      0.569    0.0    0.0
7710208    6.67e6      0.554    0.0    0.0
7710209    6.86e6      0.535    0.0    0.0
7710210    7.06e6      0.5125    0.0    0.0
7710211    7.26e6      0.4975    0.0    0.0
7710212    7.45e6      0.475    0.0    0.0
7710213    7.65e6      0.4565    0.0    0.0
7710214    7.85e6      0.434    0.0    0.0
7710215    8.04e6      0.4115    0.0    0.0
7710216    8.24e6      0.385    0.0    0.0
7710217    8.43e6      0.3625    0.0    0.0
7710218    8.63e6      0.340    0.0    0.0
7710219    8.83e6      0.314    0.0    0.0
7710220    9.02e6      0.2875    0.0    0.0
7710221    9.22e6      0.254    0.0    0.0
7710222    9.41e6      0.224    0.0    0.0
7710223    9.61e6      0.190    0.0    0.0
7710224    9.81e6      0.1375    0.0    0.0

```



```

7710225 10.0e6 0.059 0.0 0.0
7710226 10.15e6 0.0 0.0 0.0

```

*

```

7800000 bichrg tmdpvol
7800101 4.375 10.0 0.0 0.0 0.0 0.0 0.0 0.0
7800200 3
7800201 0.0 1.013e+5 310.0

```

*

```

7810000 bichrg tmdpjun
7810101 780000000 790000000 2.552e-3
7810200 1 510 p 248010000
7810201 -1.0 0.0 0.0 0.0
7810202 0.0 0.0 0.0 0.0
7810203 0.0 0.13 0.0 0.0
7810204 15.0e6 0.13 0.0 0.0

```

*

```

7900000 bleccsin snglvol
7900101 9.079e-4 16.0 0.0 0.0 0.0 0.0 3.333e-5
7900102 0.0 0.0
7900200 0 15488401. 83231.356 2445531.5 0.0

```

*

* intact loop secondary pressure control

```

*8160000 jctdv1 tmdpvol
*8160101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 0.0
*8160200 2
*8160201 0.0 6.54e+6 1.0
*8160202 2900.0 6.54e+6 1.0
*8160203 3000.0 2.70e+6 1.0
*8160204 5000.0 2.70e+6 1.0

```

*

```

8200000 jctdv2 tmdpvol
8200101 1.0e+8 10.0 0.0 0.0 0.0 0.0 0.0 0.0
8200200 2
8200201 0.0 6.54e+6 1.0
8200202 2500.0 6.54e+6 1.0
8200203 2600.0 2.70e+6 1.0
8200204 5000.0 2.70e+6 1.0

```

*

* boundary system for steady state

```

9900000 bdryvol delete

```

*

```

9890000 bdryviv delete

```

*

*

```

20574000 "mass err" sum 1.000000 0.000000 1
20574001 -14488.61 1.0 cntrlvar 720
20574002 1.0 cntrlvar 915

```

*

```

20591900 auxfeed sum 1.0 0.0 1
20591901 0.0 1.0 mflowj 351000000
20591902 1.0 mflowj 353000000

```

*

```

20591700 intfeed sum 1.0 0.0 1
20591701 0.0 1.0 mflowj 361000000
20591702 1.0 mflowj 351000000
20591703 1.0 mflowj 353000000

```

*

```

20591800 brkfeed sum 1.0 0.0 1
20591801 0.0 1.0 mflowj 561000000
20591802 1.0 mflowj 551000000

```

*

```

20592000 totwatr sum 1.0 0.0 1
20592001 0.0 1.0 mflowj 771000000
20592002 1.0 mflowj 721000000
20592003 1.0 mflowj 722000000
20592004 1.0 mflowj 731000000
20592005 1.0 mflowj 781000000

```

*

```

20592100 totalinj integral 1.0 0.0 1
20592101 cntrlvar 920

```

*

```

20592200 tothpicl sum 1.0 0.0 1
20592201 0.0 1.0 mflowj 771000000
20592202 1.0 mflowj 721000000
20592204 1.0 mflowj 731000000
20592205 1.0 mflowj 781000000

```

*

* integrated flow in broken loop

*

```

20592300 "si-cltot" integral 1.0 0.0 1
20592301 cntrlvar 922

```

*

```

20592500 "feedtot" integral 1.0 0.0 1
20592501 cntrlvar 917

```

*

20592600	"auxtot"	integral	1.0	0.0	1
20592601	cntrivar	918			
*					
20592800	"arvtot"	integral	1.0	0.0	1
20592801	mflowj	569000000			
*					
20592900	"msltot"	integral	1.0	0.0	1
20592901	mflowj	529000000			
*					
. zzz					

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(See instructions on the reverse)

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10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

The objective of the present work is to identify the predictability of RELAP5/MOD3.1 regarding thermal-hydraulic behavior during a steam generator tube rupture (SGTR). To evaluate the computed results, LSTF SB-SG-06 test data simulating the SGTR that occurred at the Mihama Unit 2 in 1991 are used. Also, some sensitivity studies of the code change in RELAP5, the break simulation model, and the break valve discharge coefficient are performed. The calculation results indicate that the RELAP5/MOD3.1 code predicted well the sequence of events and the major phenomena during the transient, such as the asymmetric loop behavior, reactor coolant system (RCS) cooldown and heat transfer by natural circulation, the primary and secondary system depressurization by the pressurizer auxiliary spray and the steam dump using the intact loop steam generator (SG) relief valve, and so on. However, there are some differences from the experimental data in the number of the relief valve cycling in the affected SG, and the flow regime of the hot leg with the pressurizer, and the break flow rates. Finally, the calculation also indicates that the coolant in the core could remain in a subcooled state as a result of the heat transfer caused by the natural circulation flow even if the reactor coolant pumps (RCPs) turned off and that the affected SG could be properly isolated to minimize the radiological release after the SGTR.

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RELAP5/MOD3, CAMP, SGTR

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